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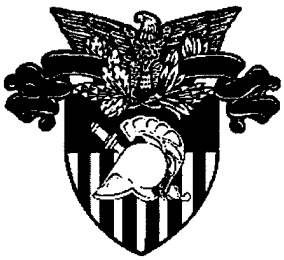

United States Military Academy
West Point, New York 10996

RESEARCH PLAN

OF THE

OPERATIONS RESEARCH CENTER
AND
DEPARTMENT OF SYSTEMS ENGINEERING

FOR THE

ACADEMIC YEAR 2004

Lietenant Colonel Michael J. Kwinn, Jr., Ph.D.
Director, Operations Research Center of Excellence

Colonel William K. Klimack, Ph.D.
Associate Professor and Acting Head, Department of Systems Engineering

Brigadier General Daniel J. Kaufman, Jr., Ph.D.
Dean of the Academic Board, United States Military Academy

The Operations Research Center is supported by the Assistant Secretary of the Army (Financial Management and Comptroller).

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INTRODUCTION

The purpose of this document is to formalize the research and problem-solving activities of the *U.S. Military Academy Operations Research Center for Excellence* (ORCEN) for the upcoming academic year. The research plan includes a statement of purpose for the ORCEN, a description of its organization, a list of the key personnel responsible for executing the plan, and an overview of the annual research cycle. These are followed by a concise summary of each applied research or problem-solving project. The summary includes a problem statement, a proposed methodology for project execution, project requirements and deliverables, estimates of milestones, and the number of man-years required to complete the work. Additional information is provided on the senior investigator, principal analyst, the client organization, and points of contact.

The ORCEN serves as the coordinating body for all research undertaken within the Department of Systems Engineering. As such, this plan encompasses a range of projects and work performed by ORCEN Analysts, Sr. and other Faculty members and Cadets alike. These research activities are opportunities to develop research and problem-solving skills while working on problems that are of importance to today's Army.

PART I – THE OPERATIONS RESEARCH CENTER OF EXCELLENCE (ORCEN)

Purpose of the Operations Research Center

The purpose of the Operations Research Center is to provide a small, full-time analytical capability to both the Academy and the United States Army. The Operations Research Center helps to fill several Academy needs: (1) enriched education for cadets; (2) enhanced professional development opportunities for Army faculty; (3) maintenance of strong ties between the Academy and Army agencies; and (4) the integration of new technologies into the academic program.

By being fully engaged in current Army issues, the Operations Research Center assures that systems engineering education at West Point remains current and relevant. The one-year experience tour with the ORCEN offers officers assigned to the Academy, as faculty, the opportunity to engage in meaningful applied research and problem solving activities that both enhances their professional development as Army officers and keeps them current in their disciplines. The Army's return on its investment, depicted in Figure 1, is meaningful career development experiences for officers, especially those in Functional Areas 49/51/53, an enhanced education program for the West Point cadets, and important investigation of vital Army problems at far less cost than would be required through civilian contracts.

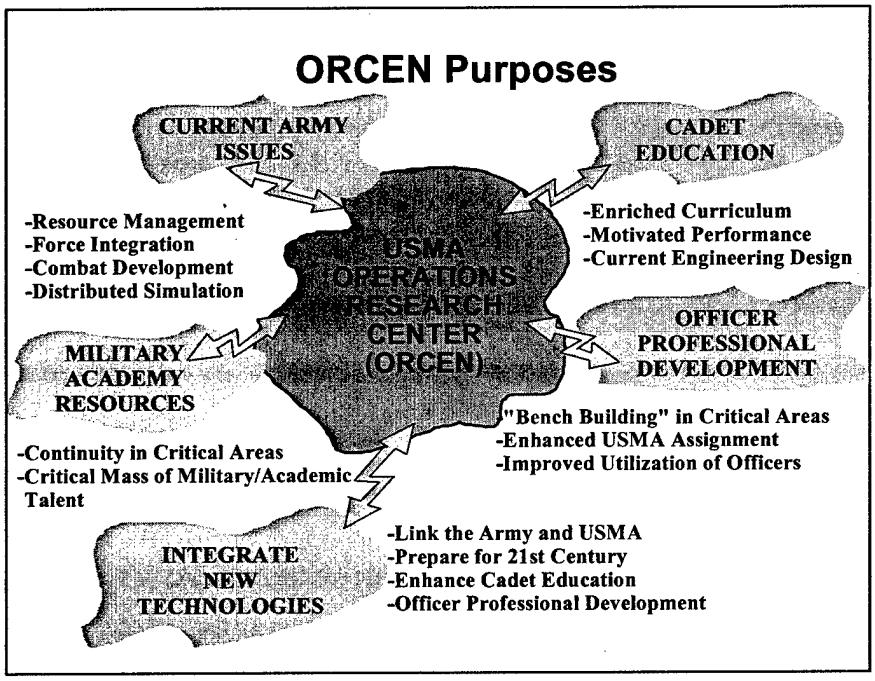

Figure 1: Purposes

Operations Research Center projects provide the faculty and cadets with the opportunity to investigate a wide spectrum of interdisciplinary, systemic issues and to apply many of the systems engineering, engineering management, and operations research concepts studied in the classroom to real-world problems of interest to the Army. These projects demonstrate for both cadets and faculty the relevance and importance of systems engineering in today's high-technology Army.

Organization of the Operations Research Center

Personnel authorizations in the ORCEN are established by a Table of Distribution and Allowances (TDA). Funding support for the Operations Research Center is established by a Memorandum of Agreement with the Office of the Assistant Secretary of the Army (Financial Management). The Operations Research Center is organized under the Office of the Dean as an Academy Center of Excellence. A permanent Military Academy professor provides oversight and supervision to the Center. In addition, the TDA authorizes one analyst, O5; three analysts, O4 and a secretary GS5. By agreement between the Department of Systems Engineering (D/SE) and the Department of Mathematical Sciences (D/MATH SCI), three analysts are assigned to the ORCEN by D/SE, and one analyst from D/MATH SCI. The Department of Systems Engineering also provides the permanent faculty member to serve as the Director and one permanent staff member to serve as Executive Administrator and assistant to the Director.

The Operations Research Center welcomes the opportunity to collaborate on Army-related projects with USMA teaching faculty from the Departments of Systems Engineering, Mathematical Sciences, and others. In addition, the ORCEN is able to provide Army officers attending graduate school and cadets enrolled in advanced individual study courses with real-world projects that are well suited for either thesis work or course projects. This in turn provides Army agencies with a greater range of expertise to address a wide spectrum of projects.

The Operations Research Center occupies office and laboratory space in the Department of Systems Engineering on the third floor of Mahan Hall. The Center includes offices for the director and analysts, and a briefing area. The Department of Systems Engineering laboratories -- Combat Simulation, Systems Management and Design, and Computer Aided Design -- are located within easy access to the Operations Research Center.

The Operations Research Center is sponsored by the Assistant Secretary of the Army (Financial Management & Comptroller). Fully staffed and funded since Academic Year 1990-1991, the Operations Research Center has made significant contributions to cadet education, faculty development, and the Army at large (see Figure 2 below for example flow of projects).

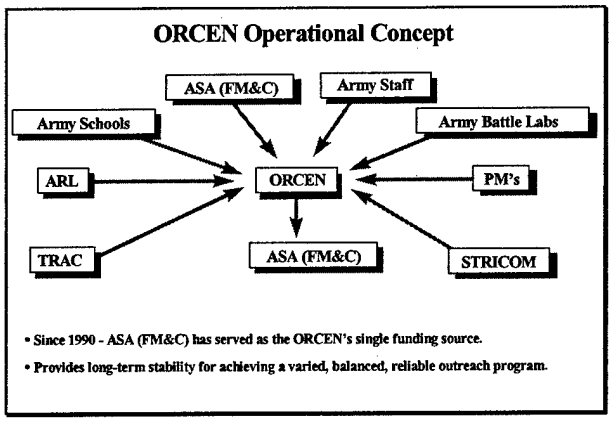

Figure 2: Operational Concept

Personnel Involved in ORCEN Research

The following is a list of key personnel from the Operations Research Center responsible for executing the Research Plan for the Academic Year 2004. A detailed description of each research project is given in Part III - PRINCIPAL RESEARCH ACTIVITIES FOR AY04.

TITLE & ORGANIZATION	NAME	PHONE (DSN)	EMAIL
Associate Professor and Acting Head, Department of Systems Engineering	COL William K. Klimack, Ph.D.	688-2701	fb5901@usma.edu
Director, ORCEN & Associate Professor	LTC Michael J. Kwinn, Jr., Ph.D.	688-5529	fm9536@usma.edu
Deputy Director, ORCEN & Associate Professor	LTC Willie J. McFadden, II, Ph.D.	688-5941	fw1793@usma.edu
D/SE Analyst & Associate Professor	Lt. Col. Edward A. Pohl, Ph.D.	688-5168	fe6428@usma.edu
D/MS Analyst & Instructor	MAJ Mark Gorak, M.S.	688-5539	am6108@usma.edu
D/SE Analyst & Assistant Professor	MAJ John Brence, M.S.	688-3573	fj7672@usma.edu
D/SE Analyst & Instructor	CPT Eric Tollefson, M.S.	688-5661	fe0398@usma.edu

These full-time analysts are augmented by permanent faculty who serve as senior investigators for each project, as well as by instructors from the Department of Systems Engineering, the Department of Mathematical Sciences, and other departments who work as primary analysts or co-analysts on ORCEN projects. The primary faculty members who will be involved in ORCEN related research this year are:

ACADEMIC RANK	NAME	PHONE (DSN)	EMAIL
Professor	Patrick J. Driscoll, Ph.D.	688-6587	fp5543@iusma.edu
Professor	Bobbie Foote, Ph.D.	688-4893	fb9690@usma.edu
Professor	Gregory Parnell, Ph.D.	688-4374	fg7526@usma.edu
Associate Professor	COL Margaret Belknap, Ph.D.	688-4625	fm0673@usma.edu
Assistant Professor	Roger C. Burk, Ph.D.	688-4754	fr6961@usma.edu
Assistant Professor	LTC William Bland, Ph.D.	688-5181	fw4948@usma.edu
Assistant Professor	LTC Rocky Gay, Ph.D.	688-3688	fr2425@usma.edu
Assistant Professor	LTC Timothy E. Trainor, Ph.D.	688-5534	ft5890@usma.edu
Assistant Professor	Paul West, Ph.D.	688-5871	fp8049@usma.edu

PART II – RESEARCH PROGRAM OF THE ORCEN

Purpose of the Research Plan

As the US Military Academy develops the leaders of tomorrow, it is important that it maintains ties to the Army of today. This document helps to highlight for Army leaders, external agencies, and visitors the important links between the Academy and the Army that are strengthened through research activities conducted by the ORCEN. The Center provides a limited number of Army agencies with dedicated, long-term, applied research and problem solving capability specializing in the application of both operations research and systems analysis (ORSA) and the systems engineering design process (SEDP). A partial listing of past clients includes the following:

Assistant Secretary of the Army for Financial Management & Comptroller (ASA-FM&C)

Office of the Deputy Chief of Staff for Operations (ODCSOPS)

Office of the Deputy Chief of Staff for Personnel (ODCSPER)

Office of the Deputy Chief of Staff for Logistics (ODCSLOG)

Training and Doctrine Command (TRADOC)

TRADOC Research and Analysis Center (TRAC)

Army Personnel Command (PERSCOM)

Various Army schools and other agencies.

The academic term research plan serves as an important planning and execution document in the development of the Operations Research Center of Excellence extended research plan.

How to Initiate a Project with the ORCEN

The Research Cycle for any given Academic Year for the Operations Research Center (ORCEN) is illustrated in Figure 3 on the following page. This is a depiction of the objective annual research cycle, which involves several processes in executing the Research Plan. Among them is the identification and evaluation of projects, the formalization and finalization of the plan, and the execution of the plan. These stages may occur concomitantly.

Throughout the year, ORCEN analysts and permanent faculty members in the Department of Systems Engineering seek to identify potential project for the out-years. At the same time, potential analysts are identified who have the abilities and desire to support each of the projects. Then, the slate of potential projects is evaluated, and a final list of projects is developed. After the academic term ends in May, new analysts from the Systems Engineering and Math faculties assume their duties in the ORCEN in support of the planned research activities. These analysts conduct an in-depth Needs Analysis with the client organizations for each project, and then finalize the research plan. Research activities throughout the year are closely coordinated with the client organizations, and normally are completed by May or June of the following year.

This cycle is the best way to ensure that a full academic year (June through May) is available to execute the research plan. This helps insure adequate time is available for the primary analysts and senior investigators to complete their research projects during the course of the academic year.

The annual research cycle benefits both incoming analysts and the ORCEN. First, it gives potential analysts an opportunity to become familiar with possible areas of research, and allows them to make their own research interests known. Second, it facilitates balancing the analytical needs of the ORCEN with the analytical skills, capabilities, and interests of the incoming analysts.

A key advantage of having the research cycle tied to the academic year is that it becomes possible to identify potential independent senior-level study projects for the fall semester of the upcoming academic year, to link specific cadet capstone design projects to the ORCEN projects. Additionally, it facilitates the opportunities for cadets to spend time during the

summer working directly with Army-related clients in Advanced Individual Academic Development courses (AIADs).

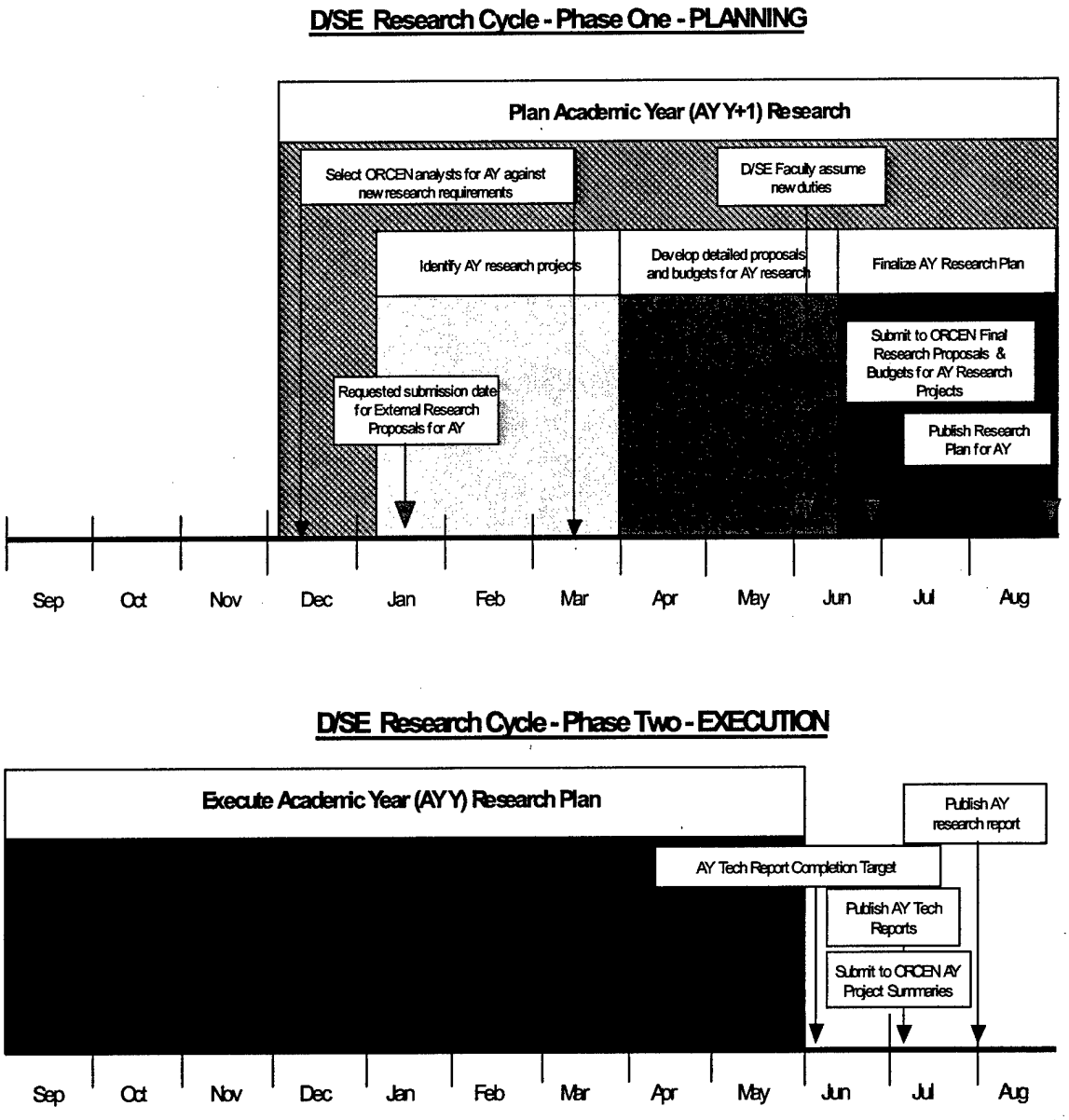

Figure 3: DSE/ORCEN Annual Research Cycle

PART III – PRINCIPAL RESEARCH ACTIVITIES FOR AY04

The following pages list each planned research project to be undertaken within the Department of Systems Engineering for Academic Year 2003-2004, otherwise referred to as AY04.

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Any questions regarding these problem statements should be directed to the D/SE Senior Investigator, the Principal Analyst, or the Client POC listed for the respective research project.

Modeling Corrosion from Eddy Current Non-destructive Tests

Research Project No.: DSE-R-0401

Client Organization: Department of Systems and Information Engineering, University of Virginia; and USAF Research Laboratories, Wright- Patterson AFB, OH

Points of Contact:

NAME:	ADDRESS:	PHONE:	OTHER:
Donald E.Brown, PhD **(PhD Advisor)**	Department Chair, Department of Systems and Information Engineering, University of Virginia	804-982-2074	brown@vriginia.edu
Ms. Deborah Peeler **(Potential Client)**	USAF Research Laboratories, Wright- Patterson AFB, OH		Deborah.Peeler@wpafb.af.mil

Problem Description: (Dissertation Research for PhD in Systems Engineering)

This research involves the development and comparison of mathematical models using non-destructive test (NDT) data from eddy current (EC) scans of the United States Air Force's (USAF) KC-135 aircraft. The models are based on the relationship between artificial and natural corrosion EC responses. The response class is based on calibration specimens (artificial corrosion) and a surrogate corrosion measurement, percent material loss. The best model(s) are be determined by analyzing the results of several different modeling processes.

Quicker, more effective methods of corrosion prediction and classification will help ensure an operationally ready fleet capable of conducting military operations worldwide. This is especially critical now, as the armed forces strive to meet the increased expense of repairing aging aircraft with a dwindling budget.

These budget constraints make it imperative to correctly determine the appropriate time to replace corroded parts. If the part is replaced too soon, the result is wasted resources. However, if the part is not replaced soon enough, it could possibly cause a catastrophic accident. The development of a model that limits the possibility of a costly accident while optimizing resource utilization would allow the military to efficiently focus its maintenance and budgetary efforts. This model would not only be useful to the military but could also apply to civilian aviation or other vehicles prone to corrosion damage. The goal of this research is to explore the framework of such a modeling tool.

Proposed Work:

- Research and Evaluate several modeling methods
- Try to improve upon best performing algorithm using theoretical hypotheses and testing

- Create a useful program that either enhances or replaces current methods of corrosion identification

Requirements and Milestones:

- Create algorithm using programming language (Spring 03-Fall 03)
- Conduct Theoretical tests on new algorithm and validate model (Spring 03-Fall 04)
- Write-up findings and defend dissertation (Fall 04 –Spring 04)

Project Deliverables and Due Date:

- Dissertation Defense (Spring 04)
- Dissertation Write-up (Spring 04)

Senior Investigator: Dr. Patrick J. Driscoll, Ph.D., Professor, USMA – Department of Systems Engineering (845) 938-6587

Faculty Analyst(s): MAJ John R. Brence, M.S., Assistant Professor and ORCEN Analyst, USMA – Department of Systems Engineering (845) 938-3573

Number of Cadets/Number of Design Teams Involved: N/A.

Supporting Laboratory Technician: N/A.

Resources Required for Project:

Research Hours Required (by position):

Senior Investigator: 100 Hours

Principal Analyst: 1,000 Hours

Lab Technician: None

Total Cadet Time: None

Lab Use Hours: None

Laboratory Technician Hours: None

US Army Recruiter Allocation Model

Research Proposal No: DSE-R-0403

Client Organization: US Army Accessions Command, US Army Recruiting Command

Points of Contact:

NAME:	ADDRESS:	PHONE:	OTHER:
LTC Rick Ayer	Chief, Research Integration and Support Center for Accessions Research, USAAC	502-626-0322	Rick.Ayer@usaac.army.mil
MAJ Vincent O'Rourke	HQ USAREC Attn: RCPAE (MAJ O'Rourke) Bldg. 1307 Fort Knox, KY 40121	502-626-1872	VINCENT.OROURKE@usarec.army.mil
MAJ Phillip Buford	CAR, USAAC HQ Ft Knox KY 40121	502-626-0404	PHILIP.BUFORD@usarec.army.mil

Problem Description:

The U.S. Army is revisiting their allocation of recruiting stations model in order to more effectively and efficiently recruit new soldiers. USAREC/USAAC wants to centrally locate their recruiting facilities in order to maintain coverage across the nation and improve recruiting efforts.

Proposed Work:

Our Team will validate the current variable inputs into the recruiting model as well as provide insight on alternative measures. We will work on a facility allocation model with a possible multi-objective function of Maximizing recruitment while Minimizing cost.

Project Deliverables and Due Date:

- Interim IPRs: Expected dates, 2003-4
- Final Briefing: Due date, 2004
- Technical Report: Due date, 2004

Senior Investigator: LTC Michael J. Kwinn, Jr., Ph. D., Associate Professor & ORCEN Director, USMA, Department of Systems Engineering, (845) 938-5529

Faculty Analyst(s): MAJ John Brence, M.S., Assistant Professor & ORCEN Analyst, Department of Systems Engineering, (845) 938-3573

Number of Cadets/Number of Design Teams Involved: None

Supporting Laboratory Technician: None

Resources Required for Project:

- **Research Hours Required (by position):**

  Senior Investigator: 1000 Hours

  Principal Analyst: 1000 Hours

  Lab Technician: 0 Hours

  Total Cadet Time: 0 Hours

Lab Use Hours: None

Laboratory Technician Hours: None

Bradley Fighting Vehicle Medium Caliber Cannon Weapon Upgrade

Research Proposal No.: DSE-R-0404

Client Organization: PM Bradley

Points of Contact:

NAME:	ADDRESS:	PHONE:	OTHER:
COL Curtis McCoy	PM-Bradley	(804)586-5318	mccoyc@tacom.army.mil

Problem Description:

Research Objective: To determine the optimum main gun for the Bradley Fighting Vehicle System through the year 2032. The gun provides lethality for the system and bore diameter is particularly important for chemical energy warheads. However, larger gun calibers reduce the capacity to store ammunition and in general have slower rates of fire. Changing the present gun system also increases costs. Given these factors, an optimum gun system will be recommended based on existing candidate systems. System lethality requires that targets can be acquired, identified, engaged, and suppressed or destroyed. Areas requiring continuing research and study include: various mission profiles and environments, acquisition mechanisms, gun caliber and rate of fire, target effects and range, ammunition types and technological risks, among many others.

Proposed Work:

USMA will support this effort through junior faculty research and weapon systems modeling in the Combat Simulation Lab (CSL). The CSL will allow the modeling of the BFVs equipped with the proposed system(s) in a Janus environment and data collected on simulated combat performance. The modeling will be conducted as an exercise in the SE485 Combat Modeling course by the cadets enrolled during the Spring Semester

Requirements and Milestones:

- Phase I – Identify the basic needs and problem definition. Literature review. NOV 02 (completed).
- Phase IIa – Theoretical approach to alternative and scenario generation. DEC 02–JAN 03 (completed).
- Phase IIb – Plan for the design process, form cadet team, develop tasks, schedule project. NOV 02 – JAN 03 (completed).
- Phase III – Analyze theoretical results. APR-MAY 03
- Phase IV – Develop practical application. JUN 2003-JUL 03
- Phase V – Develop and evaluate solution concepts. JUL - NOV 03

- Phase VI – Present findings DEC 03. Publish Interim Technical Report. JAN 04

Project Deliverables and Due Date:

- Interim IPRs: TBD
- Final Briefing: December 2003
- Technical Report: May 2004

Senior Investigator: COL William K. Klimack, Ph.D., Associate Professor and Acting Head, USMA – Department of Systems Engineering (845) 938-2701.

Faculty Analyst(s): LTC Rocky H. Gay, Ph.D., Assistant Professor, USMA – Department of Systems Engineering (845) 938-3688, MAJ Suzanne O. DeLong, M.S. , Adjunct Professor, USMA-Department of Systems Engineering, MAJ Russell J. Schott, M.S., Instructor, USMA – Department of Systems Engineering (845) 938-4752, CPT Patrick M. Downes, M.S., Instructor, USMA-Department of Systems Engineering (845) 938-3114.

Number of Cadets/Number of Design Teams Involved: 1 cadet design team of 4 or 5 SE Majors

Supporting Laboratory Technician: Mr. John Melendez

Resources Required for Project:

Research Hours Required (by position):

Senior Investigator: 80 Hours

Principal Analyst: 800 Hours

Lab Technician: 120 Hours

Total Cadet Time: (4cadets @ 2 hours/lesson for 80 lessons) = 640 Hours

Lab Use Hours: 60 hours

Laboratory Technician Hours: N/A

Soldier Tactical Mission Systems Effectiveness

Research Proposal No.: DSE-R-0305

Client Organization: PEO Soldier

Points of Contact:

NAME:	ADDRESS:	PHONE:	OTHER:
BG. Jamey Moran	PEO Soldier 5901 Putnam Road Bldg #328 Ft. Belvoir, VA 22060-5422	(703) 704-3446	jamey.moran@peosoldier.army.mil

Problem Description:

BACKGROUND: In order to remain the premier land fighting force in the world, the US Army soldier must be outfitted with the most technologically-advanced equipment possible. However, such equipment is expensive to design, test, evaluate, and implement. Therefore, proposals for such equipment should include a quantitative evaluation of the expected benefit to mission accomplishment that system or component provides the soldier and his unit.

Simulation models are a potential tool for such evaluations. However, the commonly used simulation models for analytical studies, constructive simulation models, are currently not capable of modeling the advanced soldier interaction and situational awareness that the proposed soldier tactical mission systems (STMS) facilitate.

PROBLEM: Program managers need a quantitative methodology to evaluate the benefit to mission effectiveness provided by the STMS as a whole, and by individual or groups of components.

Proposed Work:

Agent-based simulations provide the modeler a potential toolset capable of capturing the interaction between individuals on the battlefield. This project will develop a methodology for using agent-based modeling to evaluate STMS effectiveness, to include a thorough definition of the problem, selection of appropriate software, development of scenarios, development of measures of effectiveness (MOEs), design of experiments, analysis of results, and recommendations for future research and software improvement.

Requirements and Milestones:

- Initial introduction to the project — September 2003
- IPR — November 2003
- IPR — February 2004
- Final Product — May 2004

Project Deliverables and Due Date:

Interim IPRs: Estimate November, 2003, and February, 2004

Final Briefing: Estimate May, 2004

Technical Report: June, 2004.

Senior Investigator: LTC Michael J. Kwinn, Jr., Ph.D., Associate Professor & ORCEN Director, USMA-Department of Systems Engineering (845) 938-5529

Faculty Analyst(s): CPT Eric S. Tollefson, M.S., Instructor and ORCEN Analyst, USMA-Department of Systems Engineering (845) 938-5661

Number of Cadets/Number of Design Teams Involved: N/A

Supporting Laboratory Technician: N/A

Resources Required for Project:

Research Hours Required (by position)

Senior Investigator: 1 Hour/week

Principal Analyst: 20 Hours/week

Lab Technician: N/A

Total Cadet Time: N/A

Lab Use Hours: N/A

Laboratory Technician Hours: N/A

Lead-the-Fleet (LTF)

Research Project No: DSE-R-0406

Client Organization: Westar Corporation, Huntsville, AL 35805, and PM LTF, U.S. Army Aviation and Missile Command (AMCOM).

Points of Contact:

NAME:	ADDRESS:	PHONE:	OTHER:
Mike McFalls PM LTF Army Test and Evaluation	US Army Aviation and Missile Command (AMCOM) AMSAM-RD, Bldg 8716 Redstone Arsenal, AL 35898	DSN 746-3462 256-876-3462 Cell: 256-714-8362	Michael.McFalls@rdec.redstone.army.mil
Larry Thomas VP Army Programs Westar Corporation	Huntsville Engineering Center 4950 Corporate Drive, Suite 125 Huntsville, AL 35805	(256) 430-1610 Ext 104 Fax: (256) 430-1611 Cell: (256) 604-9672	Thomas@hsv.westar.com
David White VP and Chief Engineer Westar Corporation	Huntsville Engineering Center 4950 Corporate Drive, Suite 125 Huntsville, AL 35805	(256) 430-1610 Ext 124 Fax: (256) 430-1611 Cell: (256) 509-5896	White@hsv.westar.com

Problem Description:

U.S. Army helicopters are extremely complex machines designed to perform within broad operational usage envelopes. The operational usage envelopes are defined by discrete flight regimes that consist of combinations of aircraft configurations and flight maneuvers. Each regime can occur in combination with varying values of engine torque, engine speed, and rotor speed. Army helicopter system and component scheduled maintenance, overhaul, and retirement actions typically are based on calendar times and flight hours. These times are based on a —composite worst- case"(CWC) presumption of helicopter regime usage. CWC usage is derived for each U.S. Army helicopter model to capture the most severe usage that helicopter models can ever be expected to experience. Knowledge of actual operational usage can be used to identify unsafe usage, refine scheduled maintenance actions, and predict unscheduled maintenance requirements. The purpose of the Lead the Fleet (LTF) program is to gain better insight into the accumulated damage that each U.S. Army helicopter could experience during actual operational usage and to use that knowledge to evaluate overhaul and retirement times, increase safety and operational readiness, and reduce costs.

The LTF approach is to increase the flight-hour rate and usage intensity of selected Army helicopters to identify safety, reliability, availability, and maintainability (RAM), and logistics issues before they occur during normal operational usage. In this manner, system and component deficiencies can be identified, addressed, and corrected prior to fleetwide requirements for costly restorations, modifications, or retrofits. LTF provides the early opportunity to capture aircraft usage information that can be correlated with discrepancies and failures to establish meaningful usage-related safety and logistical trends. As a minimum, LTF will monitor and record the amount of time each airframe and each dynamic component is exposed to damaging flight regimes and evaluate the resultant accumulated damage. The basic parameters required to identify these flight regimes include gross weight, airspeed, altitude, roll angle, vertical acceleration, and ground-air-ground

cycles. This study is broken down into three phases: Phase 1: Reliability methodology and process development supporting the engineering analysis of aircraft usage; Phase 2: Transition Phase I products to fleet-wide application; and Phase 3: Transition complete, LTF Team receives and begins processing data from the total Army fleet.

The LTF Mission Elements include:

- Conduct controlled flight in extreme environments at the highest sustained OPTEMPO in the Army to accelerate component failures and associate those failures with specific flight regimes within the mission profiles.
- Perform maintenance in a well-structured environment focusing on technical manual accuracy, repair parts quality, tools, and maintenance man-hours expended.
- Capture detailed maintenance and usage data suitable to conduct required engineering analysis and conclusions.
- Conduct in-depth engineering maintenance and usage data analysis and reporting.
- Develop methodologies and procedures suitable to conduct fleet-wide maintenance and usage data analysis.

The Operations Research Center of Excellence (ORCEN), West Point, NY will aid Lead-the-Fleet (LTF) and Westar Corporation to gain better insight into the accumulated damage that each U.S. Army helicopter could experience during actual operational usage and to use that knowledge to evaluate overhaul and retirement times, increase safety and operational readiness, and reduce costs, ultimately helping to successfully transform the Army's aircraft maintenance program from a flight time based to a usage based system.

Proposed Work:

During the first year of this multi-year effort, the ORCEN will dedicate a full time analyst plus additional faculty and possible cadet involvement to provide statistical and analytical research for LTF challenges. This research endeavor exposes cadets to individual study of real Army challenges, and enables them to make an impact on the future of the Army which they will serve. As future leaders this experience also gives them an insight into Army Aviation, and enables them to see how Lead-the-Fleet will affect future aviation operations. LTF research may provide cadets with capstone projects, design team competition, and Advanced Individual Academic Development (AIAD) opportunities.

Analysts will conduct a through review of existing documentation and interviews of appropriate personnel to fully understand the current LTF mission. Westar Corporation will provide data collection, data dissemination, clarification and comments throughout the course of this effort.

Specifically the ORCEN will:

1. Determine the duration of Phase II to support a specified level of statistical significance.
2. Validate statistics and methods used to include:
    a. Phase II correlation of fleet data to control group Phase I.

b. Number of flight hours needed to provide statistical significance between phases.

c. Criteria for a 90% confidence interval between phases and explanation of any abnormities.

d. Analyzing the possible risks associated with raising the damage index above normalized 1 (one), by considering, among other things, the stack-up of conservative assumptions made in the usage analysis approach.

3. Provide guidance and analysis to indicate the duration and/or number of iterations necessary for ATTC LTF aircraft to fly specified damaging flight regimes.
4. Provide analysis of digital collection needs to determine the uncertainty associated with regime definition assumptions, and determine the cost/benefit for obtaining additional parameters.
5. Provide West Point faculty involvement and possible summer research opportunities

Project Deliverables and Due Date:

- Interim IPRs: Expected dates NOV03: Background data, research focus, needs analysis.
  - MAR04: Final coordination of deliverables
- Final Briefing: Due date, APR04.
- Technical Report: Due date, MAY04.
- Conference Presentation: Possible Military Operations Research Society (MORS), Date TBD
- Submit article for publication (possible MORS journal), Date TBD.

Senior Investigator: LTC Michael J. Kwinn, Jr., Ph.D., Associate Professor & ORCEN Director, USMA - Department of Systems Engineering (845) 938-5529

Faculty Analyst(s): Dr. Bobbie L. Foote, Ph.D., Professor, USMA – Department of Systems Engineering (845) 938-4893, Lt. Col. Edward Pohl, Ph.D., Associate Professor, USMA - Department of Systems Engineering (845) 938-5168, MAJ Mark Gorak, M.S., Instructor, USMA – Department of Systems Engineering, (845) 938-5539; MAJ Kevin Romano, M.D., Assistant Professor, USMA – Department of Mathematical Sciences (845) 938-5620.

Resources Required for Project:

Research Hours Required (by position):

Senior Investigator: 5 Hours/wk: 210 hours

Principal Analyst: 20 Hours/wk: 840 hours

Faculty Analysts: Dr. Foote: 10 hours/wk: 420 hours; Lt. Col Edward Pohl: 30 hours; MAJ Romano: 30 hours

Small UAV Analysis

Research Proposal No.: DSE-R-0407

Client Organization: PEO Aviation, Redstone Arsenal, AL

Points of Contact:

NAME:	ADDRESS:	PHONE:	OTHER:
COL John D. Burke	Project Manager, Tactical Unmanned Aerial Vehicle Systems PEO Aviation Redstone Arsenal, AL 35898	256-895-4449	burkejd@tuav.redstone.army.mil
Mr. Jim Charlton	TUAVS PEO Aviation Redstone Arsenal, AL 35898	256- 895-4365	jim.charlton@tuav.redstone.army.mil

Problem Description:

The Program Manager for Tactical Unmanned Aerial Vehicle Systems has requested that a cadet capstone group investigate the optimal size and weight of unmanned aerial vehicles that are in the 0-50 lbs range, and are small enough to fit into a rucksack. The analysis should look at current capability within the industry and also at capability anticipated within 10 years. Current official statements of operational requirements can be used for background information or reference, but should not be regarded as strict guidelines.

Proposed Work:

Investigate the mission/problem area and develop a study plan. Investigate aircraft capabilities and availability now and in 10 year. Investigate payload capabilities and availability now and in 10 years. Analyze and trade off platform weight vs. payload, for the present and for 10 years in the future. Assess cost/performance tradeoffs. Assess system data flow.

Requirements and Milestones: TBD

Project Deliverables and Due Dates:

- IPRs: Oct 03; Dec 03; Feb 04
- Final Briefing: Apr 04
- MORSS Presentation: Jun 04
- Technical Report: Aug 04

Senior Investigator: Dr. Roger C. Burk, Ph. D., Assistant Professor, USMA – Department of Systems Engineering (845) 938-4754.

Number of Cadets/Number of Design Teams Involved: One cadet design team of three Systems Engineering majors.

Resources Required for Project:

Research Hours Required (by position):

Senior Investigator/Principal Analyst: 136 hours (4 hrs/wk for 2 semesters)

Total Cadet Time: 900 hours (3 cadets for 2 semesters)

Lab Use Hours: TBD

Laboratory Technician Hours: TBD

High Energy Laser Weapons: Modeling and Simulations

Research Project No.: DSE-R-0408

Client Organization: High Energy Laser Joint Technology Office (HEL JTO)

Points of Contact:

NAME:	ADDRESS:	PHONE:	OTHER:
Ed Pogue	HEL Joint Technology Office 901 University Boulevard SE, Suite 100 Albuquerque, NM 87106	(505)-248-8200	Ed.pogue@osd.mil
Glen P. Perram Professor of Physics	Department of Engineering Physics Air Force Institute of Technology 2950 P Street Wright-Patterson AFB, OH 45433-7765	(937)-255-3636 ext 4504	glen.perram@afit.edu

Problem Description:

The HEL JTO is coordinating the services' efforts to develop high-energy laser weapons. As part of this effort, the JTO recognized the need for end-to-end modeling of such weapons. Physics-based models exist for laser generation, beam formation and control, atmospheric propagation, and target interaction, but the JTO has no available model for a complete laser weapon shot ("photon birth to death"). Higher-level models of a military engagement, the execution of a military mission, or they carrying out of a campaign involving HEL weapons are also unavailable. It is clear that low-level, very detailed, physics-based models need to be linked in some way to higher-level engagement, mission, and campaign models, but it is unclear how this linkage should be worked.

To fill this gap, the HEL JTO asked the two service graduate schools of engineering (AFIT and NPS) and the three service academies (USMA, USNA, and USAFA) to form a consortium to research what modeling is required and to develop a model or family of models to meet the JTO's needs. AFIT agreed to lead this effort and the other institutions agreed to participate in ways appropriate to their capabilities and areas of responsibility.

The objectives of the effort are: (1) to develop a tri-service research team to integrate DoD fundamental research in end-to-end HEL modeling; and (2) to develop a government-owned, DoD-accepted global interface, which integrates existing and future HEL models. The initial focus must achieve a balance between (1) on-going, high-fidelity technical analyses, (2) engineering trade studies, which allow analyses of a wide range of systems, not simply a deep analysis of any one selected system, and (3) analyses of HEL systems' military utility against a broad range of missions.

The lion's share of the effort will be with AFIT, as the institution with by far the greatest expertise and experience with high energy lasers. The participation of USMA will primarily in evaluating how HELs are or should be modeled in ground warfare and air and missile defense scenarios, and in helping develop linkages from physics-based models to higher-level engagement, mission, and campaign models.

Proposed Work:

This is the second year of a five-year, three-phase project. This year starts Phase II, Model Development. The nature and scope of the USMA contribution to the project will be worked out in coordination with AFIT in the first months of the academic year.

Requirements and Milestones: TBD

Project Deliverables and Due Date: TBD

Senior Investigator: Dr. Roger C. Burk, Ph. D., Assistant Professor, USMA – Department of Systems Engineering, (845) 938-4754

Faculty Analyst: CPT Eric S. Tollefson, M.S., Instructor & ORCEN Analyst, USMA – Department of Systems Engineering, (845) 938-5661

Number of Cadets/Number of Design Teams Involved: None

Resources Required for Project:

Research Hours Required (by position):

Senior Investigator: 150 hours (0.1 person x 0.75 yr x 2000 hrs/yr)

Principal Analyst: 150 hours (0.1 person x 0.75 yr x 2000 hrs/yr)

Lab Use Hours: TBD

Laboratory Technician Hours: TBD

Base Realignment and Closure (BRAC) 2005: Army Installation Military Value Analysis

Research Proposal No.: DSE-R-0409

Client Organization: Deputy Assistant Secretary of the Army (Infrastructure Analyses)

Points of Contact:

NAME:	ADDRESS:	PHONE:	OTHER:
Dr. Craig College Deputy Assistant Secretary of the Army (Infrastructure Analyses)	Army TABS Office 1400 Key Blvd, Suite #2 Arlington, VA 22209-1518	(703) 697-3388	craig.college@us.army.mil
LTC William Tarantino Chief, Modeling Support Team	Army TABS Office 1400 Key Blvd, Suite #2 Arlington, VA 22209-1518	(703) 696-9529	william.tarantino@us.army.mil

Problem Description:

The purpose of this research project is to provide Base Realignment and Closure (BRAC) 2005 infrastructure analysis support to Dr. Craig College, Deputy Assistant Secretary of the Army (Infrastructure Analyses) and the Total Army Basing Study (TABS) Group. There have been four previous BRAC rounds in 1988, 1991, 1993 and 1995, during which defense officials picked 97 major domestic bases for closure, 55 major bases for realignment and 235 minor installations to be either closed or realigned. The BRAC 2005 round will be part of the Defense transformation effort with strong involvement of the OSD and Joint Staff. The services will develop their BRAC methodologies in 2003. The installation data call will be conducted in 2004. The BRAC Commission will be formed in 2005 to recommend realignments and closures to the SECDEF and President. We will develop and implement a methodology to assess the military value of each Army installation and the total Army infrastructure. The methodology will be documented in a technical report by December 2003.

Proposed Work:

Continue to identify key BRAC infrastructure and installation transformation issues and opportunities through research and interviews with Army senior leaders.

Develop an objective, credible, and auditable methodology for BRAC Army infrastructure transformation analysis and installation Military Value Analysis that will support senior Army decision makers.

Implement the Army Military Value Assessor Model using approved decision support software (Logical decisions or Excel Premium Solver Platform).

Write a white paper that describes the recommended methodology to support BRAC decision making.

The methodologies we are using are stakeholder analysis, Multiple Objective Decision Analysis, and portfolio analysis using optimization.

Requirements and Milestones: TBD

Project Deliverables and Due Dates:

- White Paper TBD
- Final Briefing TBD

Senior Investigator: Dr. Gregory S. Parnell, Ph.D., Professor, USMA – Department of Systems Engineering, 845-938-4374.

Analysts: LTC Willie McFadden, II, Associate Professor, USMA – Department of Systems Engineering, 845-938-5491, LTC Michael J. Kwinn, Jr., Associate Professor and Director, Operations Research Center for Excellence, USMA – Department of Systems Engineering, 845-938-5529, CPT John Harris, Instructor, USMA – Department of Systems Engineering, 845-938-5536

Number of Cadets/Number of Design Teams Involved: One cadet design team of three Systems Engineering majors.

Resources Required for Project:

Research Hours Required (by position):

Senior Investigator / Principal Analyst: 260 hours (10 hrs per week)

Analysts: 52 hours (2 hrs per week)

Total Cadet Time: 450 hours (3 cadets for 1 semester)

Lab Use Hours: TBD

Laboratory Technician Hours: TBD

Base Camp Analysis: Location, Layout and In-Theatre Infrastructure Assessment

DSE Project No.: DSE-R-0410

Client Organization: Construction Engineering Research Laboratories (CERL)

Points of Contact:

NAME:	ADDRESS:	PHONE:	OTHER / EMAIL:
Deb Curtin	Engineer Research and Development Center Construction Engineering Research Laboratories 2902 Newmark Dr. Champaign IL 61822	(217) 398-5567	Deborah.R.Curtin@erdc.usace.army.mil
Stuart Foltz	CFF Engineer Research and Development Center Construction Engineering Research Laboratories PO Box 9005 Champaign, Ill 61826	(217) 373-3487	Stuart.D.Foltz@erdc.usace.army.mil
Richard Marvin Marlatt	Associate Technical Director Facility Acquisition & Revitalization Engineer Research and Development Center PO Box 9005 Champaign, Ill 61826	(217) 373-7290	Richard.M.Marlatt@erdc.usace.army.mil
Kirk McGraw	Research Structural Engineer Engineer Research and Development Center Construction Engineering Research Laboratories PO Box 9005 Champaign, Ill 61826		Kirk.D.McGraw@erdc.usace.army.mil

Background:

The Engineering Management (EM) Program in the Department of Systems Engineering and the Civil Engineering (CE) Program in the Department of Civil and Mechanical Engineering at USMA want to establish a long-term relationship with both the Base Camp Project Delivery Team and the In-Theater Infrastructure Assessment Team at CERL in order to provide research support in the area of Base Camp and In-Theater Assessment studies. These areas of research support the academic objectives of the EM and CE programs at USMA, and provide a forum for both faculty and cadets to apply the concepts from their studies to a real-world military problem. This enhances the academic and professional development of both faculty and cadets as Army officers.

Problem Description:

The military increasingly needs to plan for, and execute, fast deployments of forces in support of the full continuum of military operations, from combat, peace enforcement, peacekeeping, training and stability and support operations. The Army needs the ability to plan quickly the location, layout and operations of the bases to sustain deployed forces. Planners at the theater level require the doctrinal and technological support necessary to plan, construct, operate and close base camps that are secure, efficient and environmentally sound. Future sustainment areas will be placed throughout the depth of the battlefield to

include deep, close and rear areas. Base camp development in these areas will need to be fast, while fulfilling mission, security and environmental requirements.

A functioning infrastructure not only supports the soldiers winning the war, but the building of the peace afterwards. Accurate infrastructure assessment is required prior to, during and after any conflict to provide support not only to the service members within the theater, but also the citizens caught in the middle of the conflict. Infrastructure includes not only utilities such as power, water, garbage, sewer, but also highways and bridges (WES has lead here) and the buildings supporting or housing the utilities, command and control, and soldiers in the theater. What can the Corps of Engineers do to improve the speed and accuracy of infrastructure assessment?

Presently, there is little guidance, few effective assessment tools and little training associated with infrastructure assessment. Many times the required assessment is beyond in-theater capabilities and/or available assessment tools; therefore, the current solution is to use TeleEngineering to reach-back to the subject matter experts. However, the Requests for Information (RFIs) are many times poorly phrased and contain limited to no essential information needed by the experts to provide a possible solution from a far.

The reoccurring theme through analysis of the support provided for Afghanistan and Iraq is that: (1) remote sensing efforts must be improved to provide initial infrastructure information and triage, (2) assessment tools must be developed for each engineering area of concern to provide in-theater solutions and to guide data collection for reach-back support, (3) training must be conducted with these tools from the FEST down to the individual soldier (especially at Advanced Non-commissioned Officer Courses (ANOC), Engineer Officer Basic Course (EOBC), and Engineer Officer Advanced Course (EOAC), and (4) reach-back assets must be properly supported, staffed, and recognized for the critically important and extremely valuable support they provide when RFIs are correctly worded and contain critical data.

At end state, the final product should be an integrated product that provides the decision maker with a suite of software tools that determine the location, design, construction, and operation of base camps and identifies key infrastructure and environmental concerns, force protection issues, and specific structural requirements.

Proposed Work:

The Departments of Systems and Civil and Mechanical Engineering at USMA will assist CERL in determining the requirements for infrastructure assessment and future base camp planning tools. This will be accomplished by hosting a two-day workshop during 2nd Quarter of FY04 of key military agencies involved in doctrinal development for, and operational support of, base camp operations and in-theater infrastructure assessment. In coordination with CERL, the Base Camp and Infrastructure Assessment Workshop will be a two-day event with the objective to begin development of a cradle to grave **strategic plan** to address infrastructure assessment and high priority base camp issues that arise in planning, design, construction, operation, transfer and closure:

- Identify requirements and deficiencies
- Identify proponency for base camp and in-theater infrastructure assessment issues

- Provide guidance and focus for ongoing & proposed R&D
- Provide technology transfer mechanisms for R&D products
- Validate the strategic plan

Participants will be identified/invited based on coordination with CERL and key agencies in the field. The specific agenda and responsibilities will be defined and coordinated with CERL. USMA will host the workshop, and produce a proceedings of key presentations and information captured during the workshop for distribution to participants. CERL will have approval authority over release of information.

To expand this work into the academic program, the Engineering Management Program will identify a cadet capstone project to support CERL in the area of base camp planning, while the Civil Engineering Program will offer an independent study to support CERL in the area of in-theater infrastructure assessment. These projects, specifics identified later in this document, will be accomplished during Academic Year 04-2 (Jan-May 2004) by a team of 3 Engineering Management majors (Base Camp) and a team of 2 Civil Engineering majors (infrastructure assessment), under the direction and supervision of Ph.D. faculty. The engineering management majors will apply the Systems Engineering Management Process to the specific base camp planning issue, incorporating research of existing doctrine and tools, outcomes of the base camp workshop, coordination with/input from key proponents, and past research performed in this area. This should lead to future capstone opportunities during academic year 2005. The civil engineering majors will apply the engineering design process while incorporating research of existing doctrine and tools, outcomes of the infrastructure workshop, coordination with/input from key proponents, and past (limited) research performed in this area. This should lead to future independent study opportunities during academic year 2005.

As part of their USMA experience, cadets are provided an opportunity to conduct an Advanced Independent Academic Development (AIAD) program during their summer training period before their senior year of study. Each year cadets participate in Corps Districts as project managers and at Corps Labs as researchers while others participate in uniquely designed summer programs. During FY 2001, a group of cadets visited base camps in Kosovo as part of an AIAD to expose them to the issues of operating sustainment bases. In FY02, cadets went to a base camp in the Pacific Command (PACOM) area of responsibility on an AIAD. In FY03, the EM Program sponsored cadets for an AIAD in Honduras to study base camp operations. While not addressed in this proposal, the EM and CE Programs will explore AIAD opportunities with CERL in the future.

Requirements and Milestones:

- Base Camp and In-theater Infrastructure Assessment Workshop – January-March 2004
- Capstone Design and Independent Study Team work – Jan-May 2004
- AIAD visit – June-July 2004

Deliverables:

Base Camp and In-theater Infrastructure Assessment Workshop

a. *Determine Attendees and Develop and send invitation/notification:* In concert with USACERL develop a workshop invitation to convey succinctly and concisely the objectives and intent of the workshop, participation level, and outcomes expected. Develop a web site for managing registration and distributing information prior and after the workshop.

b. *Host the Workshop:* Provide meeting space adequate for combined group and breakout groups. Each room should include powerpoint projector, white board, butcher block paper, etc. Provide logistical support (lodging and travel advice) for meeting attendees.

c. *Determine Workshop format*: In concert with USACERL determine the most optimal workshop format to meet expected outcomes. Specifically determine speakers, breakout session operation, optimal number per breakout, need for facilitators, etc. At a minimum the workshop breakout sessions will include the following topic areas:

   Organizational Stovepipes
   - Communication flows
   - Integrating environmental considerations across the life-cycle

   Site Selection
   - Assessment (environment and infrastructure)
   - Engineering, environmental baseline and sanitation input

   Design/Construction
   - Implementing Field and Technical Manuals into practice
   - Problematic transition from initial to temporary standards
   - Class IV implications for Future Force (pre-positioned assets), e.g., how does the transportation corps meet shortened deadlines?

   Operation
   - Costs
   - Security and force protection issues
   - Energy and utilities

d. *After Action Report* including, but not limited to the following expected outcomes:
   - Prioritized list of cradle-to-grave process issues
   - Identification of technology requirements and deficiencies to address
   - the issues
   - Provide technology transfer mechanisms for R&D products.

<u>USMA Civil Engineering Independent Study Project.</u>

Funds ($5,000) are provided to the USMA Civil Engineering Division (POC LTC Ron Welch) to support one or more student independent study projects in the area of forward facilities infrastructure assessment. The focus of the project(s) is to be determined by USMA in consultation with ERDC-CERL (POCs: Michael McInerney, Stuart Foltz). The following are suggested focus areas for the project:

a. Conduct a study to evaluate what can be learned from remote assessment technologies. Determine field engineer capabilities to determine the inventory and condition of buildings and utilities in a target location by interpreting currently available image data (e.g., aerial photos, IR, LIDAR).

b. Determine critical information required in TeleEngineering questions from the field to subject matter experts (SMEs). The goal is to develop guidance on what background information is needed from the field in order for remote SMEs to provide detailed and specific responses to the field questions.

c. Develop inspection aides (e.g. checklists) to assist field engineers in assessment of buildings and utilities or their return to operation.

Department of Systems Engineering Independent Study Project

Funds ($5,000) are provided to the USMA Systems Engineering Department (POC LTC Tim Trainor) to support a group study project in the area of planning and operations in support of base camps. Work to support this effort will involve:

a. Requirements Analysis, both Operations and Mission Specific, and determination of the data requirements for a future suite of software decision-support tools for operational planners. Follow-on work from this effort is earmarked for development of software decision support tools that aid higher commanders and planners at the theater level.

b. A Capstone project will deal with Phase one, the initial requirements analysis for base camp planning. The intended output of the Capstone is an Integrated Base Camp Work Package that will include base camp planning issues such as engineering and infrastructure assessment, location and layout, force protection, environmental and cultural issues.

c. Phase two will be conducted as an Academic Individual Advanced Development (AIAD) in Summer 2004 whereby a cadet team, faculty advisor and perspective representatives from CERL will travel to a base camp location to oversee base camp operations. The product from phase one will be continued in phase two and analyzed in an operational base camp environment for verification and validation. Revisions will be made as needed. The intent is to continue work on this base camp suite of decision-support planning tools in future Capstone projects next academic year.

Senior Investigator: LTC Timothy E. Trainor, Ph.D., Assistant Professor, USMA – Department of Systems Engineering (845) 938-5534, LTC Ronald Welch, Assistant Professor, USMA – Department of Civil & Mechanical Engineering (845) 938-4099.

Principal Analyst: MAJ John Cushing, M.S., Instructor, USMA – Department of Systems Engineering (845) 938-4399.

Faculty Advisor: LTC Robert Powell, Ph.D., Assistant Professor, USMA – Department of Systems Engineering, (845) 938-5311.

Number of Cadets Involved: 3-4 for the SE403 (EM Version) Capstone Design Course; 2 cadets for the CE Independent Study Project.

Supporting Laboratory Technician: None

Resources Required for Project

Research Hours Required (by position):

Senior Investigator: 200 hours

Principal Analysts: 120 hours

Lab Technicians:

Total Cadet Time: 1 semester for 3 EM cadets in AY04; 1 semester for 2 CE cadets in AY04

Lab Use Hours: 0

Laboratory Technician Hours: 0

Military Pay and Food Service Data Analysis and Forecasting

Research Proposal No.: DSE-R-0411

Client Organization: Assistant Secretary of the Army for Financial Management & Comptroller (ASA (FM&C))

Points of Contact:

NAME:	ADDRESS:	PHONE:	OTHER:
Carol Campbell	Chief, Military Personnel Division Directorate of Operations and Support Director of the Army Budget for ASA(FM&C)	703-692-8531, DSN 222	carol.campbell@hqda.army.mil
Richard Faso	Defense Supply Center Philadelphia	(215) 737-2952	Richard.Faso@dscp.dla.mil

Problem Description:

Military Personnel Division of the Directorate of Operations and Support for the Director of the Army Budget for ASA (FM&C) request a review of their data analysis and forecasting military pay-related budget items. Specifically, ASA (FM&C) would like us to recommend new systematic processes or tools to analyze this data and with which to develop recommendations for decision makers. Ms. Campbell wants to develop a better means to do trend analysis with data for the purpose of developing more robust forecasts and identify specific engineering tools that might help their office perform more efficient forecasting.

Proposed Work:

The project is divided into four parts and has the following priorities. This proposal covers work on Priority One by MAJ Greg Lamm. However, work on this project may facilitate work on the other priorities at a later date by other researchers.

a. Priority One. Develop forecasting tools for the subsistence budget (i.e., Army food service operations worldwide) and a process flow diagram in order to collect the requirements for better organizational forecasting. They periodically receive a 'bill' from DSCP (Defense Supply Center Philadelphia, http://www.dscp.dla.mil/ , a business unit of the Defense Logistics Agency (DLA)), however they do not have a good process to accurately forecast these requirements. They are particularly interested in this because they are currently having a problem with justifying USMA's subsistence accounts. They are working with CW3 Thompson from the dining facility at USMA to understand the problem. All Army dining facility requests are processed through DSCP.

b. Priority Two. The Department of Labor (DOL) pays some separated soldiers unemployment compensation. Several organizations and systems are involved with this process; DOL, Army G-1 via SIDPERs data and the G-8 for resource management. Last year, the DOL paid $38 million in unemployment compensation

to separated soldiers and eventually billed the Army for this amount. However, Ms Campbell does not have a good process to inspect/justify who is eligible and being paid this compensation. She would like an analysis of the system used in this process in order to tighten controls (This might be difficult because it will likely require coordination with the Department of Labor and other agencies external to DOD).

c. Priority Three. The Army has several soldiers, many from the Army Reserve and National Guard, assigned to work on Air Force (AF) installations, primarily to meet force protection requirements. The Army bills the Air Force for these soldiers. However, Ms Campbell does not feel confident in the amount they are billing the AF, (i.e., she does not feel confident they are using the correct data to determine this bill). She needs a systematic way to accurately capture costs at periodic intervals.

d. Priority Four. The Army mobilizes soldiers continually to meet operational requirements worldwide. The costs to mobilize, pay and sustain these soldiers are not forecasted in the Army budget because they fill requirements for contingency operations. The Army has to go to Congress for additional appropriations to pay the bill for mobilized soldiers. Ms Campbell is not confident in the cost factors they use to justify this bill. They would like an analysis of the actual costs to mobilize soldiers to use as a justification for the figures they provide to Congress. In short, they need accurate cost factors that reflect the average payroll costs to mobilize soldiers in order to defend their requests for additional appropriations from Congress.

Project Deliverables and Due Date:

- Interim IPRs: Jan 2004.
- Final Briefing: Apr-May 2004.
- Technical Report: May 2004.

Senior Investigator: LTC Timothy E. Trainor, Ph.D., Assistant Professor, USMA - Department of Systems Engineering (845) 938-5534.

Faculty Analyst(s): MAJ Gregory A. Lamm, M.S., Assistant Professor, USMA – Department of Systems Engineering (845) 938-4792, MAJ Linda M. J. Lamm, M.S., Assistant Professor, USMA – Department of Systems Engineering (845) 938-5663.

Resources Required for Project:

Research Hours Required (by position):

Senior Investigator: 5 Hours

Principal Analyst: 60-80 Hours

Lab Technician: N/A

Total Cadet Time: N/A

Lab Use Hours: N/A

Laboratory Technician Hours: N/A

Application of Multi-Objective Decision Analysis to the Conowingo Pool Water Resource Allocation Problem

DSE Project No.: DSE-R-04-12

Client Organization: Susquehanna River Basin Commission (SRBC)

Points of Contact:

NAME:	ADDRESS:	PHONE:	OTHER:
Glen DeWillie	SRBC 1721 North Front Street Harrisburg, PA. 17102-2391	(717) 238-0425, ext. 219	gdewillie@srbc.net
Andrew Dehoff	SRBC 1721 North Front Street Harrisburg, PA. 17102-2391	(717) 238-0425, ext. 221	adehoff@srbc.net

Problem Description:

The SRBC is a tri-state commission that manages the water resources of the Susquehanna as it traverses through New York, Pennsylvania and Maryland. They have multiple users of the river resources, many with conflicting objectives for their usage of the water. Increasing environmental legal constraints, coupled with the expanding demand have significantly heightened the awareness of users to the allocation decisions mediated by the SRBC. Of particular interest are decisions affecting the Conowingo Pool, which is a reservoir at the mouth of the river in vicinity of the Chesapeke Bay. Federal law now mandates certain water flow requirements for this pool, however the ability to meet these requirements is impacted by the amount of water allocated to the many upstream users. These users, from agricultural, industrial and recreational sectors, have conflicting objectives.

The SRBC has a work group of stakeholders involved in trying to make good decisions regarding Conowingo Pool Operations. They have a contractor that developed the Oasis Model (we do not have the software) to try and forecast the impact on the Conowingo Pool flows from upstream usage and flows. Dr. Bob Foote went through the user's manual and determined the model uses a goal program to determine what flows into/out of the usage points should be given inputs to the model. However, the model is iterative and allows for a significant amount of subjectivity in meeting stakeholder objectives. The SRBC would like another organization to look at a methodology that better grasps the competing objectives of stakeholders, and weights them appropriately in modeling usage decisions made by the SRBC. Overall, they need a quantitative, formalized decision process for allocating water resources that is traceable and can stand up to scrutiny. They need decision support tools to assist in this process.

Proposed Work:

This will likely be a two-year project using cadet capstone teams with faculty supervision. The proposed work covers these basic steps:

Apply the Systems Engineering Management Process (SEMP) to define the problem and perform a thorough stakeholder analysis. The stakeholder analysis needs to identify objectives and values for water resource allocation decisions. This process also needs to identify the appropriate measures of effectiveness for these objectives. This process will lead to a value hierarchy for the decision process.

Apply multi-objective decision analysis (MODA) methods to quantify/weight stakeholder objectives and determine value functions for the evaluation measures. The intent is to build a methodology to quantify the impact on stakeholder objectives from alternative decision policies.

Develop an optimization model for allocating flows to users that maximizes the overall management objective as defined through the MODA process.

Create a decision support system that allows the SRBC to input key information and determine how well water allocation policies, defined by flow levels to users, satisfy the competing objectives of the many users. This system should allow for sensitivity analysis of policies.

The plan is to use a cadet capstone team of Information Systems Engineering (ISE) majors during AY04 to perform a thorough problem definition and stakeholder analysis and develop a quantified values hierarchy. This team would also do the software modeling and create a stand-alone prototype of the decision support system (DSS) for a portion of the values hierarchy (to be determined), including an optimization module. This prototype would be designed with the SRBC's technical requirements in mind, and turned over to them for testing on/about May 2004. During AY05, a cadet capstone team of either Engineering Management or ISE majors would expand the DSS to a multi-user environment, enhance the graphic user interface and expand/refine the quantitative and technical aspects of the MODA process and optimization module.

Requirements and Milestones:

- Develop initial values hierarchy without weights by 1 Nov 2003.
- Develop scoring/weighting methodology for the MODA model by 15 Dec 2003.
- Complete initial prototype of decision support software for client testing by 11 March 2003.
- Provide revised prototype of decision support software for client testing by 28 May 2004.

Project Deliverables and Due Date:

- Initial Client/Stakeholder Meeting: 6 October 2003

- Interim IPRs: Expected dates, mid-November 2003, Jan 04, March 04 and May 04.
- Final Briefing of work up to and including prototype design: 5 May 2004.
- Interim Technical Report: 1 August 2004.

Senior Investigator: LTC Timothy Trainor, Ph. D., Assistant Professor & Engineering Management Program Director, USMA – Department of Systems Engineering, (845) 938-5534

Principal Analyst: CPT Robert Lenz, M.S., Instructor. USMA – Department of Systems Engineering, (845) 938-4756

Number of Cadets/Number of Design Teams Involved: One Cadet design team during AY04 consisting of three ISE Majors and one CS sequencer.

Supporting Laboratory Technician: None.

Resources Required for Project:

Research Hours Required (by position):

Senior Investigator: 40 Hours

Principal Analyst: 20 Hours

Lab Technician: None

Total Cadet Time: 480 Hours

Lab Use Hours: n/a.

Laboratory Technician Hours: 0.

Deployment Analysis and Decision Support -AY04

DSE Project No: DSE-R-0413

Client Organization: Military Traffic Management Command, Transportation Engineering Agency (MTMCTEA)

Points of Contact:

NAME:	ADDRESS:	PHONE:	OTHER / EMAIL:
Michael K. Williams	Chief, Deployability Division MTMCTEA 720 Thimble Shoals Blvd. - Suite 130 Newport News, VA 23606-2574	(757) 599-1639 DSN 927-4646	WilliamM@tea-emh1.army.mil
Bryan Reyns	Deployability Division MTMCTEA 720 Thimble Shoals Blvd. - Suite 130 Newport News, VA 23606-2574	(757) 599-1619	ReynsB@tea-emh1.army.mil
Dr. Thom Hodgson	Department of Industrial Engineering Box 7906 North Carolina State University Raleigh, NC 27695	(919) 515-5194	hodgson@eos.ncsu.edu

Problem Description:

MTMCTEA needs fast, flexible decision support tools to use in the area of deployment planning. They perform extensive sensitivity analysis on the many parameters involved in a military deployment. These include the types of forces deployed, the transportation assets used and the ports through which forces move. Current models lack the flexibility to alter parameters and generate quickly measures of effectiveness for a deployment. MTMCTEA needs models through which a deployment scenario can be quickly modeled, parameters changed as required and a solution generated.

Proposed Work:

This is a continuation of work from FY04. In FY04, we refined and delivered to the client the Deployment Scheduling Analysis Tool (DSAT). This software decision-support tool allows the user to perform quickly sensitivity analysis for military deployment planning. During FY04, we also trained potential users, updated database information and refined the software based on user comments. We also started a validation and verification efforts of DSAT output against the existing model MTMCTEA uses for deployment planning, the Joint Flow and Analysis System for Transportation (JFAST).

The proposed continued work for FY05 includes:

- Upgrading the DSAT software to be more stable in execution, and to incorporate many user-requested options/functions. This work will be performed by a professional programmer under contract to USMA.
- Conduct validation and verification testing of DSAT against current models (JFAST) and report results to MTMCTEA.
- Training users of DSAT as required.
- Performing database updates as required.

Requirements and Milestones:

The primary milestones are:

- Upgraded DSAT software complete by professional programmer – on/about Jan 2004.
- 1st major database update complete Jan 2004.
- Verification/validation testing and analysis reports – ongoing.

Deliverables:

- New version of DSAT – Jan 04.
- Verification/validation report Aug 04.

Senior Investigator: LTC Timothy E. Trainor, Ph.D., Assistant Professor, USMA-Department of Systems Engineering, (845) 938-5534.

Faculty Analyst: LTC Barbara Melendez, Assistant Professor, USMA-Department of Mathematical Sciences, (845) 938-7436

Number of Cadets Involved: None.

Supporting Laboratory Technician: None.

Resources Required for Project:

Research Hours Required (by position):

Senior Investigator/Faculty Analyst: 1 hours/week x 52 weeks = 52 hours for Sr. Investigator; 1 hour/week x 52 weeks = 52 hours for Faculty Analyst.

Total Cadet Time: 0.

Lab Use Hours: 0

Laboratory Technician Hours: 0

Homeland Defense Crisis Response Research & Readiness Center

Research Proposal No.: DSE-R-0414

Client Organization: The Armaments Research & Development Center (ARDEC) at Picatinny Arsenal, NJ.

Points of Contact:

NAME:	ADDRESS:	PHONE:	OTHER:
Thomas McWilliams	TACOM-ARDEC AMSTA-AR-TD Bldg 1, 3rd Floor Picatinny Arsenal, NJ 07806-5000	(973)724-2660	tamcwill@pica.army.mil
Dr. Floyd Ribe	Public-Private Partnership Office Bldg 1, Floor 3 AMSTA-AR-WE Picatinny Arsenal, NJ 07806-5000	(973) 724-6165	fribe@pica.army.mil

Problem Description:

In December 2002, ARDEC entered into a partnership with USMA to gain support for research efforts in the area of Homeland Defense. The principle project involved determining the requirements for a research and training center for Homeland Defense to be built at Picatinny Arsenal. During 2nd, 3rd and 4th quarters of FY03, USMA formed a multi-disciplinary research team, headed by the ORCEN in the Department of Systems Engineering to do the requirements determination for such a Center. The intent was to design a Center for use by both DOD and civilian emergency response agencies in preparing for Homeland Security/Defense activities. In June 2003, the USMA team turned over a recommended Master Plan for the Center that included:

- The location, sizes and type facilities to be built for this Center situated on the specific terrain identified by Picatinny Arsenal;
- A framework to plan/execute training for users (crawl, walk, run model);
- A list of the specific types of training, and research areas of focus, to execute at the Center based on a needs analysis of potential users;
- An estimate of the cost to construct the Center by facility, and a recommended phasing of the Center development;
- An estimate of the resources required to staff and run the Center;
- A list of issues to be resolved (primarily environmental restrictions of the terrain identified for the Center) in order for the Center to move forward in development.

As of June 2003, the federal funding to support the Center development was not available. However, Picatinny Arsenal was designated the New Jersey Center of Excellence for

Homeland Security Technologies, Regional Readiness and Training by GOV McGreevey in March 2003. Based on this, ARDEC is active at the state of New Jersey level in planning/organizing Homeland Defense activities for state and local agencies. While creating a federal Center at Picatinny Arsenal may not be possible, ARDEC is working with the Communications and Electronics Command (CECOM) in providing training and research for Homeland Defense issues for federal, state and local agencies outside of DOD.

Proposed Work:

This is a continuation of the work done during FY03. ARDEC is partnering with CECOM to create a training & research Center for Homeland Defense issues to support the New York/New Jersey Metropolitan Transportation Authority (MTA). MTA subways, buses, and railroads move 2.4 billion New Yorkers a year, about one in every three users of mass transit in the United States and two-thirds of the nation's rail riders. MTA bridges and tunnels carry nearly 300 million vehicles annually — more than any bridge and tunnel authority in the nation.

This vast transportation network — North America's largest — serves a population of 14.6 million people in the 5,000-square-mile area fanning out from New York City through Long Island, southeastern New York State, and Connecticut. The proposed work is to help ARDEC/CECOM to identify the specific requirements for a Center for the MTA, and to modify our existing Master Plan to meet the specific needs of the MTA.

ARDEC has also asked USMA to provide a representative to the New Jersey State-level Homeland Defense issues working group as a subject matter expert in training requirements determination. We will support this if the ARDEC idea is accepted by the working group.

Requirements and Milestones:

Undetermined. ARDEC is in the initial proposal stages with CECOM and the MTA. They requested our help, but the scope is yet to be fully determined.

Project Deliverables and Due Date:

Again, undetermined until the scope is better defined by ARDEC in coordination with CECOM and the MTA. Likely, the deliverable will be a refined Center Master Plan tailored to the specific needs of the MTA. Also, a specific deliverable will likely be LTC Trainor's participation on the New Jersey State Working Group for Homeland Defense issues.

Senior Investigator: LTC Timothy Trainor, Ph. D., Assistant Professor and Director of the Engineering Management, USMA-Department of Systems Engineering, (845) 938-5534.

Faculty Analyst(s): LTC (P) Ronald Welch, Ph.D., Associate Professor, USMA-Department of Civil and Mechanical Engineering. (845) 938-4099, LTC (P) Darrall Henderson, Ph.D., Assistant Professor, USMA-Department of Mathematical Sciences, (845) 938-4544, Dr. Frank Wattenburg, Ph.D., Professor, USMA-

Department of Mathematical Sciences, (845) 938-5618, Dr. Michael Matthews, Ph.D., Professor, USMA- Department of Behavioral Sciences and Leadership,(845) 938-3696, Dr. John Brockhaus, Ph.D., Associate Professor, USMA-Department of Geography & Environmental Engineering, (845) 938-2063, MAJ Christina Schweiss, Assistant Professor, USMA-Department of Social Sciences, (845) 938-2811.

Number of Cadets/Number of Design Teams Involved: Undetermined, but likely will include one Cadet design team from the Department of Civil & Mechanical Engineering to assist with the facility location, layout and general design for the Master Plan.

Supporting Laboratory Technician: None.

Resources Required for Project:

Research Hours Required (by position):

Senior Investigator: 80 Hours

Principal Analyst: Aggregate estimate for team is 120 Hours

Lab Technician: None

Total Cadet Time: 80 Hours

Lab Use Hours: None.

Laboratory Technician Hours: None.

Distributed Sensor Network (DSN) Sensor Management

Research Proposal No.: DSE-R-0315

Client Organization: Sensor and Electron Devices Directorate, Army Research Laboratories, Adelphi, MD

Points of Contact:

NAME:	ADDRESS:	PHONE:	OTHER:
Mr. John Eicke	Director, Signal and Image Processing Division Sensor and Electron Devices Directorate Army Research Laboratory Adelphi, MD 20783-1197	301-394-5000 ext. 2626	jeicke@arl.army.mil
Dr. Nino Srour	Chief, Battlefield Acoustics Branch Signal and Image Processing Division Sensor and Electron Devices Directorate Army Research Laboratory Adelphi, MD 20783-1197	301-394-2623	nsrour@arl.army.mil
Dr. Sandor Der	Scientist, Signal and Image Processing Division Sensor and Electron Devices Directorate Army Research Laboratory Adelphi, MD 20783-1197	301-394-0807	sder@arl.army.mil

Problem Description:

The Sensor and Electron Devices Directorate (SEDD), the principal Army organization for research and development in sensors and electron devices, has expressed an interest in having us conduct research to investigate distributed sensor network (DSN) management strategies. DSNs are sensor fields consisting of intelligent, disparate sensors that are distributed spatially and geographically. Most DSNs include remote, unattended sensors, assets which create new capabilities but also introduce new constraints on power and communications resources. These constraints have created a renewed interest in developing sensor management strategies that increase the efficiency of DSN operations.

Proposed Work:

Investigate the mission/problem area and develop a study plan. Investigate current sensor management techniques. Investigate proposed sensor management techniques. Use simulation to assess the relative performance of the various techniques.

Requirements and Milestones: TBD

Project Deliverables and Due Dates:

- IPRs: Mar 04
- Final Briefing: Apr 04

- MORSS Presentation: Jun 04
- Technical Report: Aug 04

Senior Investigator: LTC William S. Bland, Ph. D., Assistant Professor, USMA – Department of Systems Engineering (845) 938-8115.

Number of Cadets/Number of Design Teams Involved: One cadet design team of three Systems Engineering FOS cadets or Sequencers.

Resources Required for Project:

Research Hours Required (by position):

Senior Investigator/Principal Analyst: 136 hours (4 hrs/wk for 2 semesters)

Total Cadet Time: 450 hours (3 cadets for 1 semesters)

Lab Use Hours: TBD

Laboratory Technician Hours: TBD

Logistics Decision Support System for Maneuver Battalions

Research Project No: DSE-R-0415

Client Organization: PM Logistics Information Systems (PM-LIS), Fr. Lee, VA

Points of Contact:

NAME:	ADDRESS:	PHONE:	OTHER:
COL David Coker	Project Manager, Logistics Information Systems Ft. Lee, VA		cokerd@lee.army.mil
Mr. Jim Washburn	Deputy PM, Logistics Information Systems Ft. Lee, VA	804-734-7662	wasburnj@lee.army.mil

Problem Description:

The Logistics Decision Support System will facilitate better and more efficient logistics forecasting by maneuver units. The decision makers who will use the system are the maneuver battalion support platoon leaders and the battalion S-4s.

Proposed Work:

Develop a DSS that can imported to a Palm Pilot to assist in the logistics forecasting done by maneuver units, and in particular, Battalion support platoon leaders and Battalion S-4s.

Requirements and Milestones:

Task	Date
Project Kickoff	Aug 03
Problem Definition	Sep 03
Research	Oct 03
Prototype Development	Nov 03
Present Prototype at INFORMS	Nov 03
Prototype Evaluation	Feb 04
Recommendations	Apr 04
Technical Report	May 04

Deliverables: Prototype and technical report summarizing findings and recommendations.

Proposed Required Dates for deliverables: 30 May 04

Senior Investigator: Dr. Gregory S. Parnell, Ph. D., Professor, USMA-Department of Systems Engineering (845) 938-4374

Principal Analysts: MAJ Holly West, M.B.A., Instructor, USMA-Department of Systems Engineering (845) 938-2510, MAJ Elizabeth Schott, M.S., Instructor, USMA-Department of Mathematical Sciences (845) 938-4014, CPT Jim Jackson, M. S., Instructor, Department of Electrical Engineering and Computer Science (845) 938-5555

Supporting Laboratory Technician: Software support.

Resources Required for Project:

Research Hours Required (by position):

Senior Investigator: 1 hours per week, 36 weeks = 36 hours

Faculty Analyst: 2 hours per week, 36 weeks = 72 hours

Total Cadet Time: 0 hours

Lab Use Hours: 3 hours per week.

Laboratory Technician Hours: 1 hour per week, 25 weeks = 25 hours

Information Reliability & Uncertainty

Research Proposal No.: DSE-R-0417

Client Organization: Office of Force Transformation, OSD

Points of Contact:

NAME:	ADDRESS:	PHONE:	OTHER:
Gary A. Agron, LTC (P) Transformation Strategist	OSD Office of Force Transformation 1401 Wilso Blvd, Ste 301 Arlington, VA 22309-2306	703.696.5716 (DSN 426)	gary.agron@osd.mil

Problem Description:

Given the dependency of the NCW/NCO framework upon mixed-sensor networks and information networks in general, we propose to develop a stochastic framework to assess the reliability of information products manufactured by these networks and the subsequent impact of this reliability upon the precision, accuracy and confidence associated with these products. This explanation will focus on decision points throughout a host of information networks in both deterministic and stochastic settings.

A limited number of earlier efforts to characterize reliability of information products focused exclusively on reliability as a means of describing the effects of data error in financial accounting internal control systems (AICS) (Bodner (1975), Cushing (1974), Stratton (1981)). A stochastic model was developed by Yu and Neter (1973). Stratton (1981) performed a field test and provided methodologies for determining confidence bounds for the reliability of an AICS. Bodnar (1975) discussed the implementation problems associated with using the reliability approach to model behavioral AICS. Stratton(1981) attempted to demonstrate the feasibility of a reliability model for the AICS. While these approaches demonstrated some degree of promise, none addressed the fundamental question of what reliability means with respect to information, rather than data entry. Most attempts at modeling AICS were never implemented due to the lack of realism, difficulty encountered in modeling behavioral systems, lack of cost effectiveness, and lack of understanding by practitioners. And those that were restricted their attention to transaction processing systems rather than the more difficult decision-oriented systems.

Our concern with an information network from a reliability standpoint is that data inputs come from a variety of sources, and that decisions are based in part or in whole on information products manufactured within the network. Any choice of configuration for a network should be sensitive to the transformations or manipulations induced by information flow through specific configurations of the network and how these processes maintain, enhance or degrade the reliability of these information products. To further complicate the matter, it is not clear to what extent current notions and theories of reliability validly translate to accommodate information.

The input-output process associated with transformations or manipulations can frequently be described through the use of mathematical functions. For some processes, such as concatenation, truncation, and merging, the associated function is simply an algebraic expression involving addition and subtraction. For other processes, identifying accurate functional representations is more challenging. Transformation processes involving subjective assessment or judgment on the part of a user, combining fuzzy data, intermediate optimization, or random mutation due to environmental factors may require sophisticated heuristics simply to approximate the actual behavior. However, since our concern for these processes is on how they affect information reliability, some of these harder cases readily yield their functional form by examining their process sensitivity to errors along the spectrum of input values. *There is no existing agreed upon theory governing the reliability of information with respect to battlefield information networks.* Furthermore, the earlier work noted misses the focus needed by the FCS information networks because it concentrated on whether or not data items were in error (an Information Technology issue) rather than on the processes involved with the dynamic information flow (and Information Systems issue) and how the various stages involved with this flow propagate (dampen, amplify, or pass through) critical characteristics of information products. As mentioned earlier, this distinction is subtle, but important because it establishes the appropriate domain of responsibility for various network management tasks within a unit's chain of command.

A qualitative sense of the reliability of data generation sources exists in many intelligence-gathering organizations such as law enforcement, criminal justice, and counter-intelligence agencies within the Department of Defense. Operators in these communities appear to possess a subjective understanding of the value of reliable information *sources*, i.e. those that have a repeatable record of providing insightful, accurate, albeit biased data upon which an objective logic can be imposed which transforms this data into a knowledge that can be used to guide subsequent operations, policies, practices and procedures. While such an operational understanding may be useful, the variability associated with the subjective nature of this qualification has an unknown, and we suspect unacceptable , level. Rosenthal et al. (2001) introduced a rudimentary data annotation scheme for use in GIS databases to try to reduce this variability and to tag attributes of the information that could give the end user some idea of its relative reliability. Again, however, this data annotation scheme focused on associating information reliability on information sources alone without incorporating the effects introduced within a network.

No such methodology exists that accurately represents intrinsic and external characteristic of information products manufactured in a battlefield information network of the type envisioned by the Army Force Transformation. The concept of data volatility (aka: data shelf life) has previously been introduced as a characteristic of primitive data units that is determined a priori by data quality managers in consultation with information product consumers. While such a construct is generally useful even within the framework we propose to develop, data volatility fails to adequately represent either the dynamic nature of information products in a network nor the critical link with the ensuing decisions made. The principal research question is whether information as an entity separate from their sources possesses describable characteristics of reliability that provide meaningful insights and information relative to the operations of the FCS?

Investigating information reliability within the context of information product manufacturing poses several intriguing questions. What is information reliability and how does it differ from information assurance? Can information reliability be functionally modeled, and if so, how? Do

the standard rules of probability that enable aggregation of subsystem reliability apply to information reliability as well, or is there some other functional composition rules that are better suited to represent characteristics such as independence, influence and interaction? Is information reliability within a battlefield network configuration invariant with respect to or dependent upon time? What factors does information reliability depend upon? Do any of the well-developed concepts and procedures associated with current Reliability Theory apply? To what degree do reliable and non-reliable information affect the timing and quality subsequent decisions made? Is a preset or adaptive weighting called for? What effect does/should the reliability of information have on data-heavy decision tools in general? For example, if a base camp planning software tool is constructed upon intelligent agents that can automatically retrieve categorical information (e.g., geology, weather, terrorist activity, etc.) across a wide spectrum of data sources, should this data be assigned different influence coefficients depending upon its relative reliability or objectivity? If so, how? Most importantly for the specific application of this study, how does the variance in information reliability propagate to various decision points in an FCS network? And, do any or all of these answers generalize to a system of systems environment?

Proposed Work: (3 year study)

1. Develop a robust theory of Information Reliability based on both decision and targeting networks
1. intended for use in an NCW/NCO environment, including fully automated sensor-to-shooter networks.
2. Develop and test appropriate quantitative metrics for information precision and quality consistent with the NSI concepts expressed in section 8.1 of the PSI.
3. Develop a method for identifying a proposed information critical path capable of categorizing the relative importance of information flow processing actions throughout a network.
4. Develop appropriate reliability limit theorems capable of identifying metrics that could provide clues as to how to remediate unsatisfactory situations,
5. Examine the appropriateness of concepts associated with stochastic supply chain management with regards to information maintenance along the information critical path in NCW/NCO networks.

Project Deliverables and Due Date:

- Interim IPRs: March, May, July 2004, in conjunction with IR Workshops held at USMA during the same periods.
- Final Briefing: September 2004.
- Technical Report: September 2004.

Senior Investigator: Patrick J. Driscoll, Ph. D., Professor of Operations Research, USMA – Department of Systems Engineering, (845) 938-6587

Co-Investigators Analyst(s): Edward Pohl, Ph.D, Associate Professor, University of Arkansas – Department of Industrial & Systems Engineering; Michael Tortorella, Ph.D., Research Professor, Department of Industrial & Systems Engineering, Rutgers University, New Jersey, (732) 445-5474.

Number of Cadets/Number of Design Teams Involved: TBD.

Supporting Laboratory Technician: None.

Resources Required for Project:

Research Hours Required (by position):

Principal Investigator: Driscoll (2 months)

Co-Investigator(s): Pohl (1.5 months); Tortorella (3.0 months)

Lab Technician: None

Total Cadet Time: TBD

Lab Use Hours: 0

Laboratory Technician Hours: 0

Information Logic & Impact of Incomplete Information

Research Proposal No.: DSE-R-0418

Client Organization: Office of Force Transformation, OSD

Points of Contact:

NAME:	ADDRESS:	PHONE:	OTHER:
Michael Tortorella, PhD Professor	Industrial and Systems Engineering Rutgers State University of New Jerse 96 Frelinghuysen Road Piscataway, NJ 08854-8018	732-445-5474	mtortore@rci.rutgers.edu
Edward Pohl, PhD Associate Professor	Department of Industrial & Systems Engineering University of Arkansas Fayetteville, Arkansas.	TBD (1 Jan04)	Edward.Pohl@usma.edu
Gary A. Agron, LTC (P) Transformation Strategist	OSD Office of Force Transformation 1401 Wilso Blvd, Ste 301 Arlington, VA 22309-2306	703.696.5716 (DSN 426)	gary.agron@osd.mil

Problem Description:

In the past five to ten years, military systems research and development has experienced a heightened interest in battlefield sensing technologies and techniques, principally motivated by both the design goal of *leveraging information* to gain unsurpassed battlefield dominance by a transformed Army, and a desire to reduce the overall operational risk imposed on soldiers performing precarious tasks in a variety of deployment scenarios.

This motivation has led at least in part to decision support information systems that must contend with an overwhelming amount of data and information driven by advances in data collection. And while new approaches to sensor data handling have been proposed to satisfy some of the performance demands of these systems, tacit to such approaches is a design assumption that the quality of the information in such systems increases as the data sample size generated by battlefield sensors increases in both number and dimensional representation.

There are several key issues worth investigating in this context. First, the buildup of data currently observed in NCW/NCO networks is predicated on the concept of *enumerative inference* which states that evidence in support of a specific inference is accumulated over time and more evidence accumulated over time directly enhances the quality of this information. While this certainly may be true in-part, blanket acceptance of this philosophy leads to the design and fielding of increasingly more complex information networks capable of processing, storing and exploiting this information. And, at some point, such complexity is passed on to the user to contend with.

In an effort to avoid such complexity, one might adopt a philosophy consistent with economic theory concerning decision relevant information which posits that information

that does not alter a pre-existing decision is not information; it is only serves to confirm the decision that has been made. While such a parochial position has appeal, it may fail to recognize the various functions and needs that information supplies in a military context. For example, we believe that there is measurable military value in *confirmatory* information in real time targeting networks despite the fact that it does not typically alter the decision to engage and merely serves to reinforce the conclusion that the choice to engage was correct. This type of information is suspected to be critical if such systems are to develop and maintain trust in the eyes of the user.

In contrast, *eliminative inference* provides a philosophical basis for supporting logical inference by seeking to find contradictory evidence that negates alternative explanations. It is this logic that facilitates proving theorems incorrect by identifying relevant counter-examples. Taken at its extreme, eliminative inference is captured in the words of Sir Arthur Conan Doyle through the voice of Sherlock Holmes, "when all other possibilities have been eliminated, what remains is true."

We propose that it may be possible to combine both forms of inference, enumerative and eliminative, within the logical design of a simplified fusion algorithm, much in the same way that primal-dual approaches have been exploited in mathematical programming. In this manner, such an approach should be able to exploit a portion of the in-flow buildup of real time opportunistic information yet limit the extent of overload by simultaneously imposing criteria that would enable a culling of possibilities through eliminative logic.

We also propose that returning to a first principles approach toward structuring the information organization required to support such an algorithm would be beneficial. In May of 2003, the co-investigator finished testing a the prototype framework for a new logical ontology based on a finite set of operational states being decomposed into a finite set of key descriptors (not assumed to be mutually exclusive) that accumulated evidential support from sensor network flows. A continuation of this idea to enable this system to dynamically identify new key descriptors from observed battlefield behavior is what comprises the first principle approach herein.

In the earlier work, we demonstrated the feasibility of reducing the information needed to identify and classify enemy operational states based on restricted sensor input. In that study, we applied three different network simulations: Bayesian Belief Networks, Modal Logic, and Fuzzy Set Membership, to demonstrate that a simplified information organization structure based on core information requirements is sufficient to accurately classify operational states.

For this study, we propose to extend and modify this initial approach in the following way. We still maintain a finite number of operational states as defined by doctrine, but allow for a non-finite number of key descriptors supporting the classification of state actions. This non-finite set will include a capability to work with unknown/unclassifiable actions, and thereby develop a dynamic facility to enlarge the number of key descriptors as the battlefield situation evolves. We also propose to embed metrics capable of assessing the degree of independence of key descriptor sets, the so-called minimum ontological overlap, associated with these sets. This measure provides a quantitative sense of the strength of classification and inference concerning operational state.

We also propose to develop a quantitative definition and metric for information leverage based on information asymmetry so as to better understand tradeoffs associated with investments in NCW/NCO versus conventional operations. In this sense, leveraging information becomes a competitive action to move the boundary between what is known and unknown about the enemy operational state(s) in such a manner that the boundary resides in a region that it is 'safe' to make operational decisions. The current dissertation work of Hoyt that I am co-directing is directly supporting of this concept. The questions of interest here are best stated in the context of the fire/no fire decisions, and one that is faced by all services: how long should one wait until deciding to fire on a suspected target in the NCW/NCO network context? Does there exist a "safe to decide" range based on the proportion of present versus missing information? How does security classification of such information affect this range or threshold value? What are the appropriate metrics for measuring this range? Is this range dependent upon the quality of information (measured in some quantitative manner)? How should the risk of waiting be quantified? These questions are relevant to decisions made in the face of missing or unavailable information, and has special application to situations involving a time-risk tradeoff, whether they are ground, air, or sea-based. A common example of where this problem arises can be seen when ground based elements are willing to wait to engage until higher resolution information products are available.

Lastly, we propose that the rate of asymmetry transfer (TBD) as a function of system characteristics defines leveraging information to achieve the NCW/NCO goals. Moving the boundary between known and unknown enemy information constitutes the action associated with this rate. The difference between friendly rates of asymmetry transfer and others defines the relative metric commonly referred to as *information dominance*. This metric inherently recognizes the advantages of technology investments, training and education of humans in the loop, and efficiency and effectiveness of NCW/MCO networks. The amount of battlespace dominance this achieves versus some alternative investment directly addresses a concern expressed by OSD-OFT.

Proposed Work: (3 year study)

1. Develop a general information ontology based on operational states, key descriptors, and an associated logic structure that uses a complementarity approach with enumerative and eliminative inference logic.
2. Develop a stochastic method for binning battlespace observations that will enable us to detect and

1. classify new key descriptor evidence emerging in real time.
2. Demonstrate the effectiveness of this approach using several major inference network models.
3. Develop a methodology for dynamically adjusting the partitioning of information between known and unknown elements in order to identify and characterize thresholds at which decisions can be safely made.
4. Identify the threshold levels at which a decision maker is 'safe' in making inferences concerning

5. population characteristics (aka: target identifiers) in the face of missing data and/or information.

Project Deliverables and Due Date:

- Interim IPRs: March, May, July 2004, in conjunction with IR Workshops held at USMA during the same periods.
- Final Briefing: September 2004.
- Technical Report: September 2004.

Senior Investigator: Patrick J. Driscoll, Ph. D., Professor of Operations Research, USMA – Department of Systems Engineering, (845) 938-6587

Co-Investigators/Analyst(s): LTC Pamela Hoyt, ABD Ph.D, Instructor, USMA - Department of Systems Engineering, (845) 938-2788, CPT Steven Henderson, M.S., Instructor, USMA - Department of Systems Engineering, (845) 938-5535.

Number of Cadets/Number of Design Teams Involved: TBD.

Supporting Laboratory Technician: None.

Resources Required for Project:

Research Hours Required (by position):

Principal Investigator: Driscoll (2 months)

Co-Investigator(s): Hoyt (4.0 months); Henderson (3.0 months)

Lab Technician: None

Total Cadet Time: TBD

Lab Use Hours: 0

Laboratory Technician Hours: 0

Simulation Study for Automated Soldier Power Management,

DSE Project No: DSE-R-0420

Client Organization: PEO Soldier, Ft. Belvoir. Note that this work is in direct support of the PEO Power and Energy Working Group at USMA. Hence, the client for this project is the USMA Team Chief, LTC Massie in the Department of Civil & Mechanical Engineering.

Points of Contact:

NAME:	ADDRESS:	PHONE:	OTHER:
LTC Darrell D. Massie, Ph.D., P.E.	Dept. of Civil & Mechanical Engineering United States Military Academy West Point, New York 10996	DSN 688-4037 (845)938-4037	Darrell.massie@usma.edu

Problem Description:

There is currently no centralized power management process for the Land Warrior operating system. The system will likely benefit in terms of power demand reduction from such a process, however there is no way to articulate/measure these benefits to the Program Managers short of developing a prototype that can be tested. USMA has a multi-disciplinary working group, the PEO Power & Energy working group, headed by LTC Massie that has recommended to PEO Soldier that a system of power switches be designed into future generations of the Land Warrior. However, the USMA team needs simulation analysis support to quantify the benefit from such a system of switches, and to design alternative types and locations of switches.

Proposed Work:

An Engineering Management Capstone team will develop/refine alternatives for power management in the Land Warrior and build a simulation model to evaluate these alternatives. The goal of this work is to convince decision makers that a remote power management system is beneficial for the Land Warrior system, and to provide analysis of potential alternatives that can be designed into a future generation Land Warrior. Work will be in direct support of the USMA PEO Power & Energy Working Group.

Requirements and Milestones / Deliverables & Due Dates:

- Simulation Model designed and built by April 2004.
- Draft technical report (Capstone Project Report) completed 15 May 2004.
- Technical report with analysis of alternatives completed by 1 Sept 2004.

Senior Investigator: Dr. Bobbie Foote, Ph. D., Professor; USMA-Department of Systems Engineering, (845) 938-4893, LTC Timothy Trainor, Ph. D., Assistant Professor, USMA-Department of Systems Engineering, (845) 938-5534.

Number of Cadets/Number of Design Teams Involved: Cadet design team (3 EM majors).

Supporting Laboratory Technician: None.

Resources Required for Project:

Research Hours Required (by position):

Senior Investigator: 40 Hours

Principal Analyst: 0 Hours

Lab Technician: 0 Hours

Total Cadet Time: 160 Hours

Lab Use Hours: 30 hours of the CSL.

Laboratory Technician Hours: 5.

Simulation Roadmap for Program Executive Office (PEO) Soldier Programs

Research Proposal No.: DSE-R-0421

Client Organization: Program Executive Office (PEO) Soldier

Points of Contact:

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Problem Description:

Background: PEO Soldier requires simulations that represent the dismounted Infantry soldier in enough detail to model that soldier's interaction with other soldiers, the enemy, and the environment, for use in the analysis of alternatives (AOA) process. Such a simulation package must be robust enough to model advanced concepts like tactics (both current and potential), command and control, shared situational awareness, soldier fatigue, and information overload, in addition to weapons effects and terrain characteristics. It must be sensitive to technological advances in weapons, sensors, and equipment. Traditionally, simulation innovations in these areas have been a result of a capabilities-based approach in which specific capabilities have been added to existing software to satisfy a certain niche. However, given the scope of the Army's transformation and the fact that most existing simulations were designed for large-scale, force-on-force engagements, PEO Soldier requires analysis that steps back from improving existing simulations to determine the precise simulation requirements that will support their decision making. From there, a simulation solution can be designed to meet PEO Soldier's needs.

Discussion: The process of identifying a path forward for PEO Soldier must begin with defining the characteristics of the individual soldier and his environment that the simulation must model. We must accurately describe the soldier tactical mission system (STMS), its components (existing, in-development, and future), and its potential configurations. We must determine the environments that the soldier will operate in, as well as the level of resolution at which the environment must be represented. We must identify the mission scenarios in which the soldier could be involved. Key to this analysis is the consideration of the future, both in terms of potential technological advances and of operational requirements. We can then develop a set of requirements that a simulation, or family of simulations, must satisfy in order to successfully meet PEO Soldier's AOA needs, to include required functions, objectives, and evaluation measures. As part of this process, we will simultaneously identify the data required to support such a modeling effort.

Once we have identified the simulation requirements, we can begin to consider alternative solutions. Part of this process is looking at current simulations (existing and in development) and comparing their capabilities to the requirements. We will also consider the feasibility of modifying or linking current simulations, or developing an entirely new

simulation software. By comparing the alternatives, we will be able to recommend the best solution.

Based on that candidate solution, we will determine a roadmap to its successful implementation. Such a roadmap will consist of a phased implementation timeline that will include sequential and parallel efforts, key milestones, intermediate objectives, essential tasks, and the critical path, as well as required lifecycle costs. It will also include potential short-term solutions, based on extant or easily-modifiable capabilities.

Conclusions: As the Army continues to move forward to transform the force, the simulations required to support that transformation must keep pace. PEO Soldier has identified a simulation shortcoming that must be addressed to support fully their role in the Army's transformation. Therefore, we propose to first identify their requirements, then determine the best course of action, and finally to develop a roadmap that will provide them a path forward toward a solution worthy of today's Infantry soldier.

Proposed Work:

Problem Definition

1. Conduct a detailed literature search of related work.
2. Conduct detailed interviews of key stakeholders (Army and DoD agencies, industry, subject matter experts (SMEs), etc.), as required.
3. Determine a revised engineering problem statement.
4. Determine a value hierarchy for the comparison of alternatives.
5. Focus of problem definition is to:
    a. Determine general PEO Soldier simulation requirements for AOA.
    b. Accurately describe the soldier tactical mission system (STMS) for purposes of modeling, including current, in-development, and future systems, components, and configurations.
    c. Identify the operational environments that must be modeled.
    d. Identify the mission scenarios that must be modeled.
    e. Conduct a futures analysis to account for changes in technology and operational requirements.
    f. Determine the functions and objectives required of a simulation, or family of simulations, to meet PEO Soldier AOA requirements for current and future programs.
    g. Determine appropriate evaluation measures for alternative comparison.
    h. Determine the data necessary to support the identified simulation requirements.

Design and Analysis

1. Generate candidate alternative solutions.

2. Determine the requirements for developing a new simulation software.
3. Survey existing simulations, and those under development, to determine:
    a. The degree to which they do or do not meet the requirements;
    b. The potential for modification to meet the requirements;
    c. The potential for linkage between simulations.
4. Survey existing data to aid in the determination of a data collection plan.

Decision Making

1. Compare the alternative solutions.
2. Recommend the best alternative.

Implementation:

Determine a roadmap for the implementation of the best alternative, to include:

1. A phased timeline;
2. Intermediate objectives;
3. Essential tasks;
4. Critical path;
5. Implementation costs;
6. Lifecycle costs.

Requirements and Milestones:

Milestone	**Date**
Soldier system described	25 Nov 03
Simulation requirements determined	30 Jan 04
Simulation development process identified Current simulations/data surveyed	16 Apr 04
Implementation plan complete	31 Aug 04
Technical report complete	30 Sep 04

Project Deliverables and Due Date:

- Interim IPRs: Monthly
- Final Briefing: May, 2004.
- Technical Report: August, 2004.

Senior Investigators: LTC Michael J. Kwinn, Jr., Ph.D., Associate Professor and Director, Operations Research Center of Excellence, USMA-Department of Systems Engineering, (845) 938-5529, Dr. Paul D. West, Ph.D., Assistant Professor, USMA-Department of Systems Engineering, (845) 938-5871, Dr. Bobbie L. Foote, Ph.D., Professor, USMA-Department of Systems Engineering, (845) 938-4893.

Faculty Analyst(s): CPT Eric S. Tollefson, M. S., Instructor and Analyst, Operations Research Center of Excellence, USMA-Department of Systems Engineering, (845) 938-5661

Number of Cadets/Number of Design Teams Involved: N/A

Supporting Laboratory Technician: TBD

Resources Required for Project:

Research Hours Required (by position):

Senior Investigator: 60 Hours

Principal Analysts: 750 Hours

Lab Technician: TBD

Total Cadet Time: N/A

Lab Use Hours: Combat Simulation Lab (40 Hours)

Laboratory Technician Hours: N/A

Multi-Mission Selective Maintenance Decisions

Research Project No: DSE-R-0422

Client Organization: The Logistics Institute (TLI), University of Arkansas, Fayetteville, AR

Sponsoring Agency: Air Force Research Laboratory, Human Effectiveness Directorate, Logistics Readiness Branch, Wright Patterson AFB, Dayton Ohio

Points of Contact:

NAME:	ADDRESS:	PHONE:	OTHER:
C.. Richard Cassady, Ph.D.	The Logistics Institute Department of Industrial Engineering 4207 Bell Engineering Center Fayetteville, AR 72701	(479) 575 - 6735	cassady@engr.uark.edu

Problem Description:

All military organizations depend on the reliable performance of repairable systems for the successful completion of missions. The use of mathematical modeling for the purpose of modeling repairable systems and designing optimal maintenance policies for these systems has received an extensive amount of attention in the literature. Unfortunately, the vast majority of this work ignores potential limitations on the resources required to perform maintenance actions. This shortcoming has motivated the development of models for selective maintenance, the process of identifying the subset of actions to perform from a set of desirable maintenance actions. Previously, we have developed a class of mathematical models that can be used to identify selective maintenance decisions for the following scenario – A system has just completed a mission and will begin its next mission soon. Maintenance cannot be performed during missions; therefore the decision-maker must decide which components to maintain prior to the next mission. The selective maintenance models considered to date treat decision-making relative to a single, future mission. If a system is required to perform a sequence of missions, then the selective maintenance decisions directly affect system reliability for the next mission and indirectly affect the system reliability for later missions. The primary objective of this project is to develop a modeling-based methodology for managing selective maintenance decisions when the planning horizon is more than one future mission.

Proposed Work:

Achieving the objective of this project requires the completion of several key activities. First, we will modify the existing selective maintenance models into a multi-mission problem formulation. To complete this activity, we will extend the problem parameters and decision variables to account for multiple missions and capture the stochastic relationship between the decision variables for mission t and the input parameters for mission $t + 1$. Second, we will define an appropriate objective function that captures system reliability across the entire sequence of missions. Given the stochastic nature of the

problem, we will most likely use a weighting approach that gives heavier weight to the reliability of closer missions. Third, we will define an approach for solving the multi-mission problem. To do this, we will use the single-mission selective maintenance model in conjunction with a discrete-event simulation model that mimics the completion of missions. After each simulated mission, we will use the single-mission selective maintenance model to determine optimal decisions for the break prior to the next mission. For smaller problems, we will use enumerative approaches to determine the optimal selective maintenance decisions. For larger problems, we will use search-based heuristics to make these decisions. Finally, we will study the multi-mission problem using extensive numerical experimentation. This experimentation will be used to test our solution approaches, to gain insights into the multi-mission problem, and to identify "rules of thumb" for managing the multi-mission selective maintenance problem.

Requirements and Milestones:

The methodology used in this project will be applicable to any repairable system that performs a sequence of missions with system maintenance between missions. With the guidance of our USAF partners, we will apply our methodology to a set of hypothetical systems that are representative of commonly-used Air Force systems.

Milestone 1 – System Defintion – Dec 31, 2002

We will begin by defining a set of hypothetical systems for study. These systems will be defined such that they capture the key elements of real USAF systems. For each system, we will define a reliability block diagram (RBD) that incorporates the critical components for the system.

Milestone 2 – Multi-Mission Selective Maintenance Modeling – Jun 30, 2003

We will extend existing selective maintenance models by including expanding the planning horizon to multiple missions. This will require the modification of the models' parameters and decision variables. Furthermore, we will be required to capture the stochastic relationship between the parameters/decision variables for mission t and the parameters for mission $t + 1$. The objective function for the multi-mission models will be a weighted average of the mission reliability values, with heavier weight being applied to nearer missions.

Milestone 3 – Multi-Mission Solution Procedures – Dec 31, 2003

We will develop a solution procedure to solve the multi-mission problem. We anticipate using a simulation-based approach to capture the stochastic elements of the problem, and we expect to use the single-mission problem as part of this procedure.

Milestone 4 – Numerical Analysis – May 31, 2004

We will study the multi-mission problem via extensive numerical experimentation. Our goal for this experimentation is to compare the results for mission 1 to comparable results for the single-mission problem. This comparison will indicate the necessity of using the multi-mission model as opposed to using the single-mission problem is a sequential fashion. Regardless of the outcome, we hope to gain insights into the multi-mission problem that can be used in developing rules of thumb for managing the selective maintenance problem.

Milestone 5 – Documentation – Jun 30, 2004

Throughout the project, we will document our research and provide regular updates to our USAF partners. As part of this documentation effort, we will prepare a comprehensive final report at the end of the project.

Project Deliverables and Due Dates:

- Interim IPRs: Jan 2003
  Jul 2003
  Nov 2003
  Mar 2004
- Final Briefing: Jun 2004
- Technical Report: 30 Jun 2004.

Principal Investigators: University of Arkansas Graduate Student, USMA Junior Faculty Member (TBD)

Senior Investigators: C. Richard Cassady, Ph.D. (University of Arkansas-Grad Student), Lt Col Edward A. Pohl, Ph.D., Associate Professor, USMA-Department of Systems Engineering (845) 938-5168

Faculty Analyst(s): Junior Faculty member - TBD

Number of Cadets/Number of Design Teams Involved: None

Supporting Laboratory Technician: None

Resources Required for Project:

Research Hours Required (by position):

Senior Investigator: 10 hours per month

Principal Analyst: 20 hours per month

Lab Technician: None

Total Cadet Time: None

Lab Use Hours: N/A

Laboratory Technician Hours: N/A

A Comparative Analysis of Methods for Assessing Cost and Schedule Risk for Major Defense Acquisition Programs

Research Project No: DSE-R-0423

Client Organization: Office of the Secretary of Defense, Program Analysis and Evaluation, Cost Analysis Improvement Group (CAIG), Operations Analysis and Procurement Planning Division, Room BE 829, The Pentagon, Washington, D.C. 20301 - 1800

Points of Contact:

NAME:	ADDRESS:	PHONE:	OTHER:
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Mr. Steven M. Miller (GS-15)	OSD PA&E OAPPD BE 829, The Pentagon Washington, D.C., 20301- 1800	(703) 692-8039	Steven.miller@osd.pentagon.mil
Mr. Brian Gladstone	OSD PA&E OAPPD BE 829, The Pentagon Washington, D.C., 20301- 1800	(703) 697 - 0319	Brian.Gladstone@osd.pentagon.mil

Problem Description:

Historically, cost and schedule estimates for many of the Department of Defenses Major Acquisition Programs have severely underestimated the cost and effort required for the programs. There are many reasons why this occurs but one may be that the initial program estimates are overly optimistic. This optimism may be a result of the estimating methodology utilized by the acquisition agencies. Many agencies estimate program costs using parametric cost estimating tools on the major elements in the Work Break Down Structure. Each of the elements in the WBS are viewed and estimated individually. When analyzing the risk associated with each of these elements most analysts represent costs and schedule risk with triangle distributions. However, history tells us that a skewed distribution (a Weibull distribution or Beta distribution) may be a better representation of reality. Even using skewed distributions, it has been hypothesized by the OSD CAIG (Mr. Steve Miller) that program estimates will still be severely underestimated when using the WBS modeling approach. He has hypothesized that doing risk analysis at the WBS level does not represent the reality associated with how costs and schedule are impacted during program execution. The biggest concern is that the impact of correlation is ignored in the WBS modeling technique. By ignoring the inherent relationships between the various cost elements and assuming that they are independent our estimates are always going to be overly optimistic.

Proposed Work:

OSD would like someone to attempt to quantify the level of optimism associated with performing cost estimates using the WBS modeling approach. In order to do this, we will investigate the use of a scheduled based modeling approach where each of the major tasks associated with the program are modeled and assigned an appropriate amount of risk. Using simulation, we will investigate the differences between a schedule based estimating approach and a WBS level modeling approach. A schedule based model and a WBS based model will be developed for a "typical" satellite acquisition program. The two models will be analyzed and distributions for program costs established. Each of the distributions will be analyzed and compared. Using design of experiments, the importance of precedence will be investigated and if possible quantified in terms of its impact on program costs estimates. The final product will be a summary of each of the modeling techniques, the pro's and con's of each, an analysis of the differences and their impact on the realism of program cost estimates.

Requirements and Milestones:

- Project Definition & Scope 15 Nov 2002
- System Definition 15 Dec 2002
- Schedule Based Model 15 Mar 2003
- WBS Based Model 15 May 2003
- Analysis of Models 1 Jul 2003
- Briefing and Report 1 Sep 2003

Project Deliverables and Due Dates:

- Interim IPRs: 15 Jan 2003, 15 June 2003
- Technical Report: 1 Sep 2003.

Senior Investigator: Lt Col Edward A. Pohl, Ph.D., Assistant Professor, USMA-Department of Systems Engineering (845) 938-5206

Principal Analyst(s): Junior Faculty Member (TBD)

Number of Cadets/Number of Design Teams Involved: SE or EM Special Study Cadet

Supporting Laboratory Technician: None

Resources Required for Project:

Research Hours Required (by position):

Senior Investigator: 80 Hours

Principal Analysts: 120 Hours

Lab Technician: 20 Hours

Total Cadet Time: 80 Hours

Lab Use Hours: Approximately 20 (CASE LAB 1 or 2)

Laboratory Technician Hours: 20

USMA Acquisition Management & Systems Design Lab Research

DSE Project No: DSE-R-0424

Client Organization: Defense Advanced Research Project Agency (DARPA)

Points of Contact:

NAME:	ADDRESS:	PHONE:	OTHER:
COL William Johnson	DARPA 3701 North Fairfax Drive Arlington, VA 22203-1714		wjohnson@darpa.mil
Dr. Anthony J. Tether	DARPA 3701 North Fairfax Drive Arlington, VA 22203-1714		atether@darpa.mil

Problem Statement:

This project applies state-of-the-art technology tools to advance integrated project/program management and systems design. Using the Acquisition Systems Management Lab (AMSD) in the Department of Systems Engineering at the United States Military Academy and program information this project will demonstrate the acquisition lifecycle benefits of using state-of-the-art tools: benefits such as shortened acquisition times and reduced costs which can be directly applied to future acquisition efforts and to the fielding of Objective Force systems.

Background:

The Department of Systems Engineering (D/SE) at the United States Military Academy is dedicated to providing an exceptional academic and research environment for our cadets and faculty. To achieve this vision the D/SE emphasizes a culture of scholarly excellence through its faculty, academic programs, research, and technology initiatives. We have identified a critical military need to conduct research in acquisition management and systems design. The Army is in a transformation process that will position it to remain the world's dominant military force through the 21st Century. This transformation requires that our analysis tools be able to assess the potential of new systems much the same way we do today. However, it also requires that we develop systems to function within integrated, interoperable, multi-echelon information architecture, new force structures and enhanced management and leadership processes. This necessitates that we look to new analytic tools, models, simulations, and federations of tools to effectively analyze the complex issues confronting our transformation efforts. These tools must be linked within a collaborative research and investigative environment that allows for a focused look at acquisition processes and policies.

Overarching Objectives:

1. Demonstrate the benefits of using a state-of-the-art Advanced Collaborative Environment and the principles of Simulation and Modeling for Acquisition, Requirements and Training (SMART) throughout the acquisition lifecycle to shorten system acquisition time, reduce costs, foster innovation and improve the coordination and synchronization of geographically dispersed program teams.
2. Enhance traditional program management and engineering management practices through the application of an Advanced Collaborative Environment and SMART principles. Likewise, investigate the use of the Modeling Architecture for Technology and Research Experimentation (MATREX) to evaluate acquisition systems using their physics based or engineering models in a distributed manner.
3. Develop a dynamic systems architecture and program lifecycle analysis of an acquisition system's requirements information flow.
4. Develop a central repository for program information that enables analysis of all linkages to include requirements documentation. For example, changes in program requirements documentation will generate cause and effect relationship information on DTLOM-PF. Facilitate early collaboration of all stakeholders.
5. Demonstrate streamlined process management capabilities that provide leaders critical information on the program's acquisition lifecycle environment thus aiding in identifying program risks, providing program auditability and reducing acquisition and fielding times of new systems critical to the Objective Force.
6. Provide virtual prototyping capability to investigate the feasibility of new system designs for acquisition research. The prototyping capability can go down to engineering level detail.
7. Provide a distributed 2D/3D immersive simulation capability incorporating live, virtual and constructive simulations. The 2D/3D immersive technology will also be utilized to investigate information visualization.
8. Establish an independent acquisition research cell dedicated to advancing the state of the practice and the state of the art of acquisition management and system design.

Expected Outcomes and Deliverables:

DARPA: Programs that DARPA sponsors will benefit from this project. DARPA can link research from other academic institutions with USMA DSE to coordinate investigation of military use capability of new technologies. DARPA gains a military "think tank" to provide independent nonbiased evaluation of projects. DARPA can introduce and evaluate new technology on the Army's future leaders.

PMs: A Program Manager will have systems architectures and program lifecycle analysis of their systems. The TSM will now be able to analyze and assess, prior to implementation, the impact of changes in program requirements on DTLOM-PF.

ASA (ALT): The products and processes resulting from this project will be available for use throughout the Army. They can also be used by the Defense Systems Management College in acquisition training courses.

USMA: The products from this project will be available for use in Systems Engineering course work. Lab capabilities will also be enhanced during this project. Professors will gain experience using the new state-of-the-art facilities/tools and be able to assist other program/project offices establish this capability. Likewise, cadets will participate in acquisition project research and learn about new systems and acquisition processes through their academic activities.

Increased development and use of ACE, virtual prototyping, MATREX, distributed 2D and 3D immersive technology.

Specific Research Projects:

1. **Adaptive Virtual Analytical Test and Research (AVATAR) Environment**

   Senior Investigator: Dr. Paul D. West, Ph.D., Assistant Professor, USMA – Department of Systems Engineering, 845-938-5871

   Background: Experience in post-hostilities Iraq, Afghanistan, and other recent Military Operations Other Than War (MOOTW) highlight the need for new tactics, techniques and procedures (TTPs) to combat adversaries who are innovative and adaptive in their tactics. The proliferation of Improvised Explosive Devices (IEDs) and ambushes by rocket-propelled grenade (RPG) and small arms teams challenges the mission and national will of the allied joint and combined forces. Countermeasures are currently tested in operational environments where real-world injury and loss of life are the metrics for evaluation.

   Description: This project will develop an analytical environment to test prospective TTPs for asymmetric operations in combined and joint MOOTW. It supports the tenets of Simulation Based Acquisition (SBA) and Simulation and Modeling for Acquisition, Requirements, and Training (SMART). It consists of three major components:

   - A full-scale virtual environment in which soldiers can test TTPs in dynamic situations against adversaries who are live, virtual, constructive, or in any required combination. The term, "avatar," refers to a synthetic human surrogate in a virtual environment.

   - A methodology for testing TTPs in the AVATAR environment. TTPs will be provided by proponent service agencies such as the U.S. Army's Training and Doctrine Command (TRADOC). This component will provide guidelines and techniques for integrating the TTPs in the testing environment so that meaningful data can be collected for evaluation.

   - An analytical framework for developing and evaluating appropriate metrics.

   Deliverable: A technical report will detail the development of the major components described above, including an evaluative use case.

2. **Dynamic System Requirements Management.**

Senior Investigator: LTC Willie J. McFadden, II, PhD, Associate Professor, USMA – Department of Systems Engineering, 845-938-5941

Background: Army institutions are transforming to meet the many and diverse challenges it will face in the future. Likewise, the Army's acquisition process is also changing to be more responsive, cost effective, and efficient. The use of collaborative environments, continuous information exchange, and knowledge management marks the new manner program offices now need to conduct business to coordinate the many facets a systems development. In this new business process, Program Managers (PM) must manage dynamic requirements throughout the lifecycle of a program. In the case of the most systems, requirements may be specified from sources such as the JSOR, ROC, and ORD. Or, they are implied or derived requirements such as safety, human factors, commercial standards or specifications, system specification, or purchase description.

Description: This project will focus on the Requirements Generation phase for the Air Mechanized XXI concept. The research will develop a dynamic system requirement analysis environment that address the development, sustainment, intra-theater transport, and, asymmetric operations capabilities. Models and simulations will be used to establish a standard framework for Program Manager to use as an engineering management tool.

Deliverable: A technical report will detail a knowledge hierarchy, which consists of a relational requirements hierarchy, information flow/control diagrams, functional decomposition, and an identification of system specifications.

3. **TTPs for Assymetric Threat (IED Detection Training)**

Senior Investigator: Dr. Niki D. Georger, Ph.D., ERDC Liaison to TRAC Monterey, (831) 656-3751.

Background: It is well established that Improvised Explosive Devices (IEDs) are being used effectively by opposing forces to create asymmetric threats against Coalition Troops in Iraq. The IEDs are relatively inexpensive to build and place in strategic locations, blending in reasonably well with surroundings. This facilitates the ability to set up ambushes and create diversions favorable to the enemy. Figures 1 and 2 below provide illustrations of recent events in Iraq where IEDs were used in an ambush against Coalition Troops. Employment of these unconventional methods creates a climate where the Troops must be on the lookout for such devices and must be able to discern the enemy intent behind them, given they exist. There is a need to assist Troops in the ability to rapidly and effectively detect and identify such devices in the environment as part of the steps in creating effective TTPs to counter this asymmetric threat.

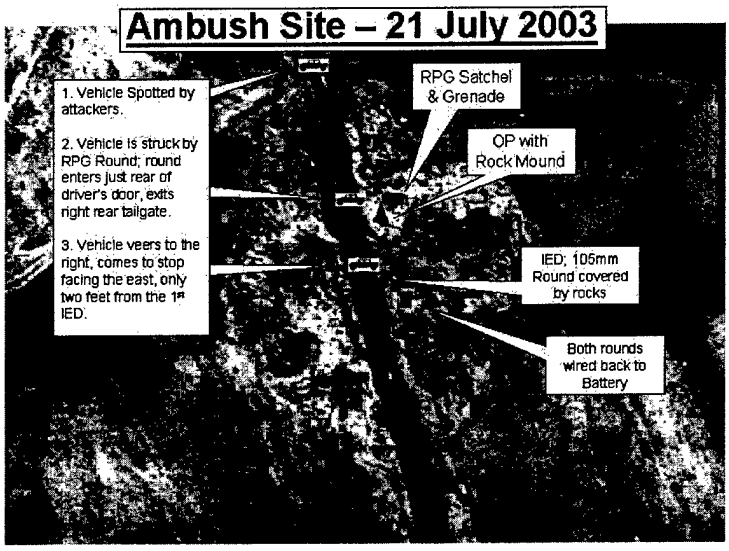

Figure 1. Layout of Actual Ambush Site in Iraq

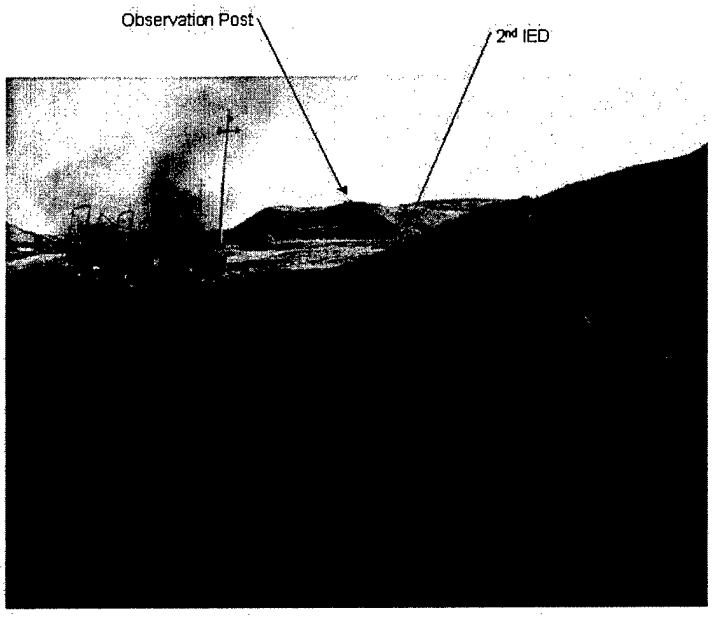

Figure 2. Photograph of ambush site with IEDs

Description: The approach will consist of the following: (a) employ the advanced virtual environment to generate 3D immersive scenarios or vignettes, including environments and situations in which there are/ are not IEDs, (b) design and run a series of experiments to surface key factors in identification of IEDs and MDMP regarding enemy course of action analysis to assist in TTP generation, (c) perform statistical analysis to identify key factors, (d) provide recommendations regarding TTP generation.

Deliverable: The objective of this research is to illuminate key factors in identification of IEDs and the Military Decision Making Process (MDMP) regarding enemy course of action analysis to assist in TTP generation.

4. Information Visualization

Senior Investigator: LTC Willie J. McFadden, II, PhD, Associate Professor, USMA – Department of Systems Engineering, 845-938-5941

Background: Most organizations consistently use 2D flat files to portray information. Information displayed in this fashion has served our organizational processes well up to this point. However, limited the display of our information in this way removes a third dimension that our minds are accustomed to perceiving. With the emergence of 3D graphics and displays it has become more assessable for organizations to display information in a 3D or immersive environment.

Description: This project will attempt to translate relational object oriented databases into 3D immersive environments that can be manipulated by a consumer of that information.

Deliverable: A technical report will detail process of developing the 3D immersive environment, including a use case.

Execution:

1. The DARPA Director through his designated representative agrees to:
   a. Support continued funding requirements for the ORCEN, USMA by assisting with programming for funding for ORCEN research support activities.
   b. Annually review research projects and associated funding for selected projects as requested by the Director, ORCEN.
   c. Coordinate and prioritize DARPA direct support analysis requirements.
   d. Provide the ORCEN direct support analysts with necessary information resources and a workspace for liaison visits, when necessary. Assist in coordinating with other Army staff agencies that are involved with DARPA direct support projects.

2. The Department Head of Systems Engineering agrees to:

   a. Provide direct analytical support to the DARPA as agreed to by the ORCEN Director and designated representative of the Director of DARPA. In order to provide diversified opportunities for applied research and analysis, the ORCEN will provide analytical support to other Army laboratories and agencies in addition to DARPA direct support project requirements.

   b. Provide ORCEN analyst support to work DARPA analysis requirements, with additional ORCEN personnel and faculty to be utilized on an as needed and as available basis.

   c. Provide a member of the permanent faculty to oversee and monitor work performed under this agreement.

   d. Provide adequate office and other facilities required for research and analysis.

   e. Utilize allocated funds to support research initiatives approved by the Head of the Department of Systems Engineering. This can include purchase, upgrade and maintenance of technology or other resources needed to support ORCEN related research, travel related to project completion, presentation of results, professional development, training, and additional analyst support, as well as resources needed for ORCEN program administration and management.

   f. Annually review and update funding needed to provide support of analysis requirements. Provide all parties with an annual research plan, detailing ORCEN research activities. Provide all parties with an annual research report, highlighting ORCEN research results.

Project Costs:

The four research projects will be funded from the $1M DARPA support. Detailed cost estimates including TDY, project specific HW and SW requirements, and contract services for programming and outside technical support will be included in our costs. Additionally, cadet academic work associated with these research proposals will also be included if appropriate.

The goal of this DSE research effort is to establish an acquisition lifecycle research capability at USMA. Consequently, to fully utilize the potential of the lab DSE requires funding to support the full time hiring of programmers, technicians, and researchers, and maintenance and logistic support, and a steady stream of research work. This would necessitate research funding that is consistent and programmed for up to 5 years.

However, for these specific research proposals, DARPA funding support will be allocated to support research project requirements and the lab's research infrastructure.

1. Infrastructure: 35% of the funded total will be consumed be infrastructure requirements. The infrastructure requirements are limited maintenance requirements. This includes hardware (HW) and software (SW) upgrades to extend research capability, technology upgrades, DIS and HLA compatibility, warranties, licenses, and contracts required to maintain lab operation.

2. Project: 65% of the funded total will be consumed be project research requirements. The project research requirements include research team TDY, associated cadet academic research TDY, project specific HW and SW, and services (includes hiring of part-time, or consulting technicians, researchers, and programmers).

Afghanistan National Development Assessment System (ANDAS)

Research Proposal No.: DSE-R-0425

Client Organization: Combined Joint Task Force – 180 (CJTF-180)

Points of Contact:

NAME:	ADDRESS:	PHONE:	OTHER:
BG Byron Bagby, Director, CJTF-180 Staff	Bagram Air Base, Afghanistan		
Major Gus Kostas, Chief, Assessment Group, CJ5)	Bagram Air Base, Afghanistan		

Problem Description:

Very early on in Operation Enduring Freedom in Afghanistan, the command group recognized the need for a comprehensive assessment support system to provide the command with a means to direct future operations and effects and to allow for reporting to CENTCOM on the current status of the operation. They requested the support of the Information Technology and Operations Center (ITOC) at the United States Military Academy at West Point to travel to Afghanistan and develop a web-based, distributed system to provide the command with this assessment capability.

The ITOC developed a system which they dubbed the Dynamic Planning and Assessment Support System, or D-PASS. At the request of the command, this system provided a subjective means to assess tasks and objectives which supported the overall operation. For the initial phases of the operation, this system achieved all the objectives set out by the command.

During subsequent operations and with a new command unit in place, it became increasing apparent that this system did not provide the assessment capability now required by the command. Specifically, the command required a system based on more qualitative assessments of the operation. To develop such a system, the command requested the support of the Operations Research Center of Excellence (ORCEN). They still wanted the system to be web-based and distributed, which led to a collaborative effort between the ORCEN and the ITOC.

Proposed Work:

Analysts from the ORCEN, augmented by a senior analyst from the Air Force Institute of Technology (AFIT), will depart to Afghanistan to analyze the needs and requirements of the system to be developed. Upon development of the more quantitative system, the ORCEN and the ITOC will collaborate in the implementation of the system into the web-based, distributed environment found in D-PASS.

Analysts from both Centers of Excellence will then return to Afghanistan to provide the new assessment system to the command. This new system will be called the Afghanistan National Development Assessment System, or ANDAS.

Requirements and Milestones:

- Early August 2003: ORCEN team arrives for initial visit to Afghanistan to assess system requirements and conduct initial model development
- Early September 2003: ORCEN team returns to West Point to complete system and begin collaboration effort with ITOC.
- Early October 2003: ORCEN team returns to Afghanistan to present proposed model to command. ITOC continues development of web-based, distributed system incorporating new model.
- January 2004 – Analysts from ORCEN and ITOC return to Afghanistan to present final model to command.

Project Deliverables and Due Date:

- IPR 1 – Initial Problem Statement, August 2003
- IPR 2 – Initial Model Development, August 2003
- IPR 3 – Completed Model Development, October 2003
- Final Briefing: Final Model, January 2004
- Technical Report: February 2004

Senior Investigator: LTC Michael J. Kwinn, Jr., Ph. D, Associate Professor and Director, Operations Research Center of Excellence, USMA – Department of Systems Engineering, (845)938-5529; COL Daniel Ragsdale, Ph. D, Associate Professor and Director, Information Technology and Operations Center of Excellence, USMA – Department of Electrical Engineering and Computer Science, (845)938-4628.

Faculty Analyst(s): Lt Col Edward A. Pohl, Ph. D, Associate Professor and Senior Analyst, Operations Research Center of Excellence, USMA – Department of Systems Engineering,, (845)938-5168; Dr. Richard Deckro, Ph.D., Professor, Air Force Institute of Technology, (937) 255-6565 x4325; MAJ John Brence, M.S., Assistant Professor and Analyst, Operations Research Center of Excellence, USMA – Department of Systems Engineering, (845)938-3574; MAJ Mark Gorak, M.S., Assistant Professor and Analyst, Operations Research Center of Excellence, USMA – Department of Systems Engineering, (845)938-5539; MAJ John Morel, M.S., Assistant Professor and Analyst, Information Technology and Operations Center of Excellence, USMA – Department of Electrical Engineering and Computer Sciences, (845)938-5559; CPT Eric Tollefson, M.S., Assistant Professor and Analyst, Operations Research Center of Excellence, USMA – Department of Systems Engineering, (845)938-5661.

Number of Cadets/Number of Design Teams Involved: None
Supporting Laboratory Technician: None

Resources Required for Project:

Research Hours Required (by position):

Senior Investigators: 250 Hours

Principal Analyst: 1800 Hours (300 hours x 6 analysts)

Lab Technician: NA

Total Cadet Time: NA

Lab Use Hours: NA

Laboratory Technician Hours: NA

Architecture for Interdisciplinary Research & Studies (R&S) at the US Military Academy (USMA)

Research Proposal No.: DSE-R-0426

Client Organization: Office of the Dean, USMA

Points of Contact:

NAME:	ADDRESS:	PHONE:	OTHER:
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Dr. Kenneth Grice	Vice Dean of Admissions USMA, West Point, NY	845-938-5007	kenneth.grice@usma.edu

Problem Description:

In support of the USMA mission, our faculty and cadets are engaged in research and studies supporting their individual areas of interest and expertise. Presently, a major proportion of our effort properly is focused on research & study (R&S) projects on behalf of the Army and the defense community. These projects support cadet and faculty development across different departments while contributing to national defense; as such they are a valuable and growing component of the four-year West Point Experience. Such interdisciplinary activities are important force multipliers; however, they also require coordination and team work to be both efficient and effective.

Presently the Academy has no formal mechanism or process that generates a coordinated Academy R&S plan that would be both beneficial for internal coordination as well as in external discussion with Army and other sponsors for adjudication, support and funding, if appropriate.

Proposed Work:

We propose to develop options that will address the policies, organization, and processes whereby USMA can plan for the conduct of interdisciplinary R&S. Our effort will be consistent with the present levels of R&S coordinated by the Academic Research Division, the MOAs existing between USMA and the DoD/DA agencies, and a possible expanded R&S effort in the future. Our recommendations will include an Academy-Army framework within which present and future (proposed) USMA R&S projects can be developed and funded cooperatively, in conjunction with USMA, Army and Defense priorities.

Project Deliverables and Due Date:

- Initial IPR: End of January 2004.
- Interim IPR: End of February 2004.
- Final Briefing & Tech Report: End of March 2004

Senior Investigator: LTC Michael J. Kwinn, Jr., Ph.D., Associate Professor and Director, Operations Research Center for Excellence, USMA – Department of Systems Engineering, (845) 938-5529.

Faculty Analyst(s): None

Number of Cadets Involved: 1 - Cadet Ryan Kent
Supporting Laboratory Technician: None

Resources Required for Project:

Research Hours Required (by position):

Senior Investigator: 100 Hours

Principal Analyst: N/A

Lab Technician: N/A

Total Cadet Time: 50 Hours

Lab Use Hours: N/A

Laboratory Technician Hours: N/A

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